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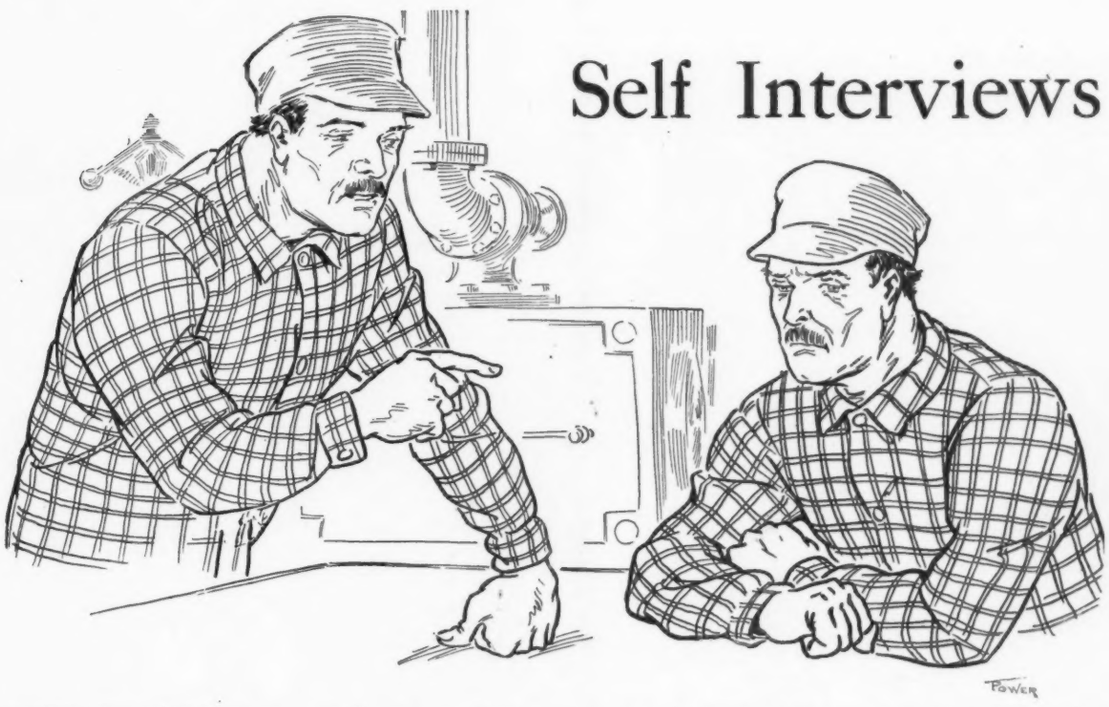
POWER

Vol. 38 NEW YORK, OCTOBER 7, 1913 No. 15

Self Interviews



THE place might have been any ordinary power plant: the time, any old time at all. John Operating Engineer sat at his desk in melancholy meditation, when in came John Operating Engineer.

□ □ □

"Good morning," says John, "what can I do for you?"

"Much! But first I'm goin' to give you a tongue lashing."

"Since you had that flare up with the general super, you've neglected things. You've said you didn't care whether you got fired or not. It's all right to be independent, but your reputation will suffer if you let the plant go to the dogs just because you're sore at one official."

"True," snapped John Operating Engineer, "but when they treat a fel—"

"That's no e x c u s e! That m a i n belt snapped yesterday simply through neglect. You let it go until so many holes broke through that it wouldn't drive a buzz-saw. When you took an hour longer than necessary to lace it, just to get square with the super you didn't think of the piece-workers who lost a good part of a day's pay, did you?

"That high-pressure steam line under the street was put down without being covered or boxed. Now it's corroded and leaks like a funnel. You're delaying repairs to it, hoping it will burst, shut down the shop and get the boss into trouble."

"He's no good, he ought to," growled John.

"I know he ain't! But you've got the wrong angle. Don't put yourself in his class. You're a good engineer. Make the plant show it!

"If he puts obstacles in your way and won't listen to reason, get out. Get another job.

"If you're big enough to do that instead of trying to get square by ill treating the plant, you're big enough for a bigger job."

With this John Operating Engineer walked out of the room, while John Operating Engineer watched him from his chair, already convinced that he would get that bigger job.

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Power Plant of Chester Valley Electric Co.

By Warren O. Rogers

SYNOPSIS—A good example of a small central station, carrying a mixed electrical load. High-pressure superheat boilers and steam turbines have taken the place of saturated-steam boilers and reciprocating engine. The condensers serving the turbines are in a concrete pit in the basement.

A great deal of attention has been given to the description of large power plants, the majority of which have been turbine installations. This type of power plant has become what might be called standard design, and is so familiar to engineers as to perhaps give the impression that turbines are not used in small power plants.

Contrary to this possible supposition there are a large number of small installations which are giving efficient and dependable service. As an instance of a small turbine proposition, the plant of the Chester Valley Electric Co., Coatesville, Penn., is taken as a typical installation.

The output of the station is used for lighting, motor circuit and for street-railway service. Like many other similar power plants the equipment comprises old and new units in both the engine and boiler rooms. The original unit in the engine room was a 500-hp. side-crank engine, directly coupled to a 525-volt generator, running at a speed of 150 r.p.m. This engine was piped to four 125-hp. water-tube boilers.

This station has placed in reserve the old boilers and the reciprocating engine and uses in their stead two 400-hp. water-tube boilers and two steam-turbine sets. One turbine drives a 625-kv.-a. alternating-current generator, the other a 940-kv.-a. generator, both three-phase, 60-cycle, 2400-volt, running at 3600 r.p.m. Both turbines, Fig. 1, are operated in conjunction with two surface condensers which are equipped with an 8-in. circulating pump and No. 14 Rotrex air pumps, both engine driven. The condensers are in a concrete-lined pit, Fig. 2, below the engine-room floor.

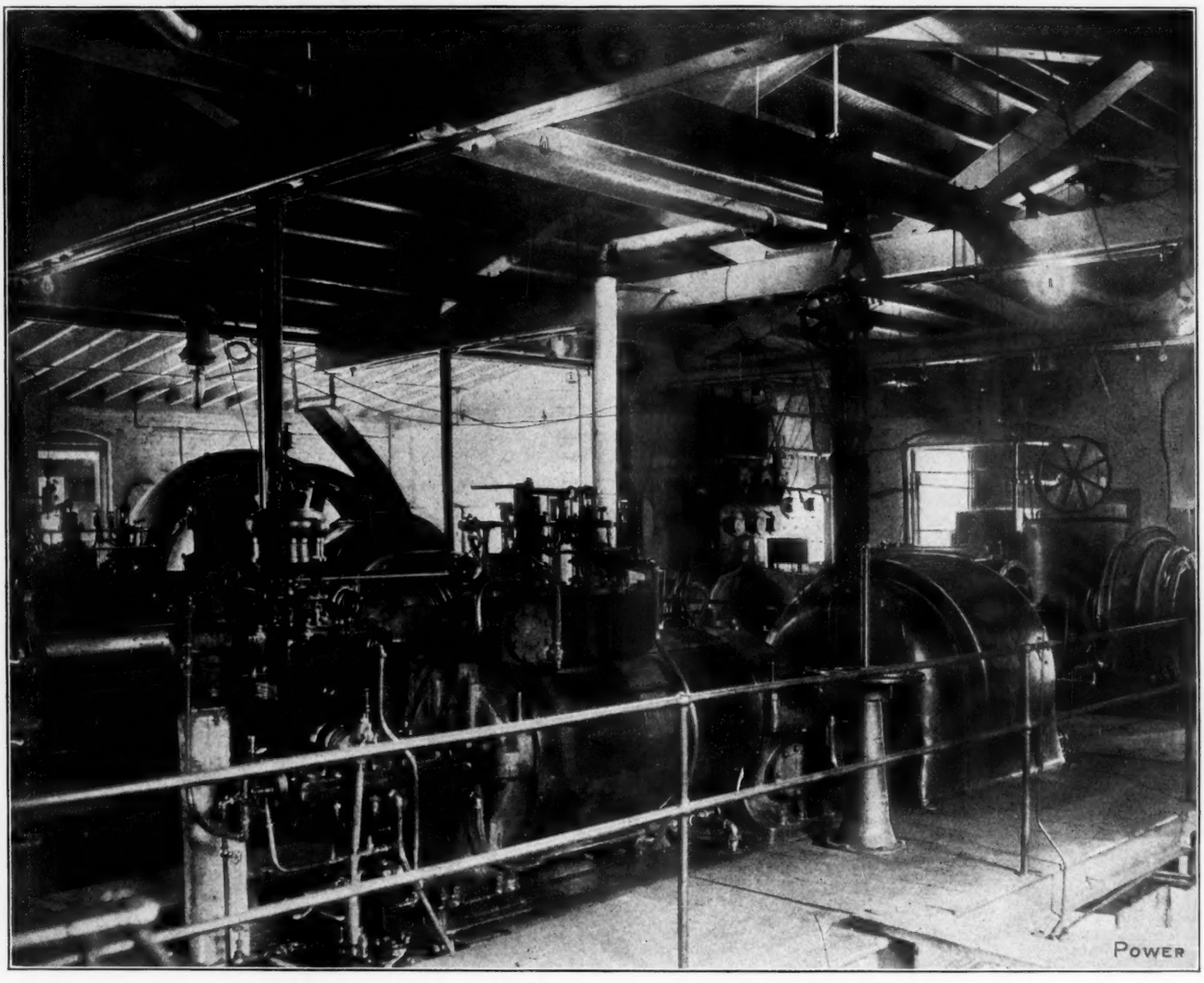

Fig. 1. View of the Turbine Room

Circulating water for the condensers is cooled by being discharged to a water-cooling tower out in the yard, as shown in Fig. 3. The discharging water flows over baffle

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slats and in dropping from one to the other is cooled. The water finally reaches the reservoir beneath the cooling tower and is again circulated through the condensers.

The cooling water goes to the tower at 100 deg. F. and

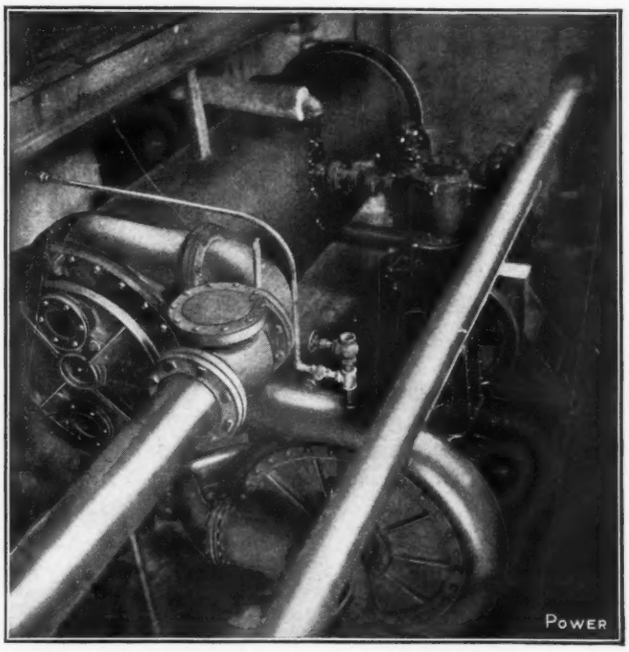

FIG. 2. CONDENSER IN CONCRETE PIT

has a temperature of 80 deg. F. in the storage tank from where it is taken by the circulating pump.

BOILER ROOM

Of the six water-tube boilers, but two are used, with the turbines. A view of the boiler room is shown in Fig.

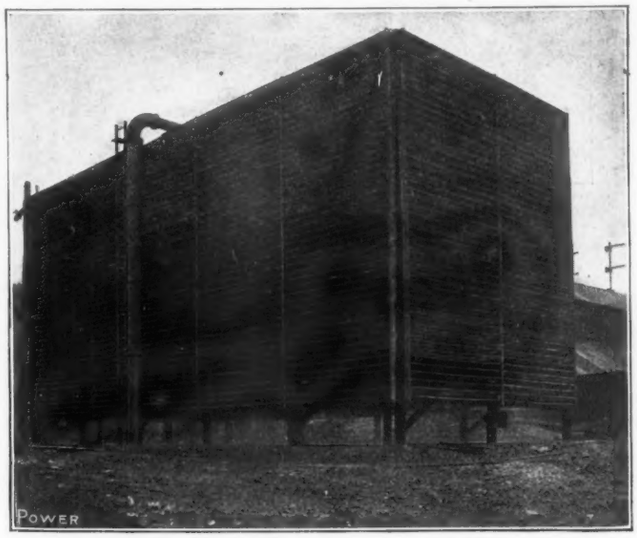

FIG. 3. WATER-COOLING TOWER

4. But one boiler and turbine are used during the day run. The boilers are piped to one main 18-in. header run above the boilers. In the turbine room the header drops to the basement to an 18-in. cross-header from which branch pipes lead to the two turbines.

Coal is delivered from coal cars on a spur track to an outside storage bin under the track trestle. It is then wheeled into the boiler room convenient for the firemen.

Feed water is handled by an open heater and either of two 10 and 6 by 10-in. outside-packed duplex pumps. These are placed in the boiler room between the batteries of boilers.

ELECTRICAL EQUIPMENT

Besides the main generators there is a 200-kw. rotary converter, three-phase, 60-cycle on the alternating side, and 600 volts of direct current. The shaft of this unit is extended, upon which a 35-kw., 550-volt direct-current generator is mounted and used for street-car and motor service.

The exciter unit is a 35-kw., 125-volt direct-current generator driven by a steam turbine at 3500 r.p.m. It is placed near the end of the turbines. A second exciter unit consists of a 30-hp., 2200-volt, three-phase, 60-cycle,

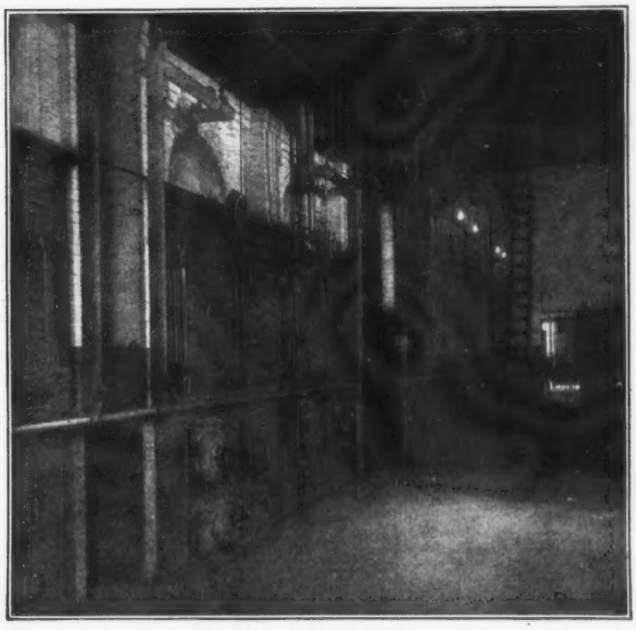

FIG. 4. PARTIAL VIEW OF THE BOILER ROOM

induction motor directly connected to a 125-volt, direct-current generator at 1130 r.p.m. The turbine exciter unit is used and the exhaust steam sent to the heater to heat the feed water, as is also the exhaust steam from the boiler-feed pumps.

Another motor-driven set is used for motor service, when run. The 75-hp. induction motor uses three-phase, 60-cycle current at 2300 volts and is directly connected to a 35-kw., 550-volt, direct-current generator driving it at 1175 r.p.m.

The switchboard, transformer, mercury rectifier, etc., are all placed at one end of the plant. The entrance to the plant, which is built of brick, is through the engineer's office, which is at one corner of the engine room. The chimney is of common brick and is built separate from the building. The form of record sheet kept at the plant is shown in Fig. 5.

It is simple and yet gives ample opportunity to record sufficient data to enable the engineers to know what the plant is doing from week to week. Running readings are taken every hour, showing the steam pressure carried, the vacuum maintained and the kilowatt-hour output

of the plant. The temperature of the feed water entering and leaving the heater is recorded, also the discharge temperature from the condenser.

Down the side of the record sheet are headings under which data regarding the electrical output for various circuits, weather conditions and hours the various units are in operation are recorded.

Chester Valley Electric Company

COATESVILLE STATION

Running Record, 6 A. M. day, to 6 A. M. day, 191

Time A. M.	Vacuum No. 1	Vacuum No. 2	Indicating K. W. Meter No. 1	Indicating K. W. Meter No. 2	Indicating K. W. Meter Total	Power Factor	TEMPERATURES	RECORDING WATTMETERS	6 A. M.	6 P. M.
6								D. C. Ry.		
7								D. C. Com.		
8								St. Area		
9								Plant		
10								Total		
11								CITY WATER METERS		
12 NOON									6 A. M.	6 P. M.
1								No. 1.		
2								No. 2.		
3									6 A. M. / 12 Noon	6 P. M. / 12 Night
4								Tem. Inside		
5								Tem. Outside		
6								Barometer		
7								Weather		
8								Coal	lbs.	STREET ARCH
9								Ashes	lbs. / 6 P. M.	6 A. M.
10								Cyl. Oil	qts.	
11								Eng. Oil	qts.	
12 MIDNT								Turb. Oil	qts.	
1								Waste	lbs.	
2								TURBO HOURS		
3								No. 1 on	off	
4								No. 2 on	off	
5								EXCITER HOURS		
6								Turbo on	off	
7								Motor on	off	
8								Rotary on	off	
9								Motor gen. on	off	
10								BOILER HOURS		
11								No. 1 on	off	
12 NOON								No. 2 on	off	
1								No. 3 on	off	
2								No. 4 on	off	
3								No. 5 on	off	
4								No. 6 on	off	
5								BOILER FEED PUMPS		
								No. 1 on	off	
								No. 2 on	off	
								COAL RECEIVED		
								Car No. / Initials / Unloaded / Hour / Weight		

Remarks:

FIG. 5. REPORT SHEET OF PLANT OPERATION

Although this power plant is small when compared with others, it is a good example of what can be done with a small central station carrying a mixed electrical load.

Jefferson Flexible Union

A new flexible union has been designed to use with pressures up to 250 lb. and over. The most important point about this type of union is that if the pipes are out of line the unions can be used as readily as if they were in line.

This union has all of the regular features of all other kinds made by the Jefferson Union Co., Lexington, Mass. The shoulder on the nut and swivel end is made spherical and concentric with the ground ball joint, and the swivel end is allowed sufficient play in the nut, so that at any angle less than 5 per cent. the union may be made tight.

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Sarco Smoke Recorder

This device was described on page 1493, Aug. 16, 1910, issue and was known at that time as the Wattles smoke register. Since being taken over by the Sarco Engineering Co., 116 Broad St., New York City, no material changes have been made with the exception of the chart, illustrated herewith, which records a wider exposure of the smoke density on a sensitive paper chart than formerly.

CHART FROM SARCO SMOKE RECORDER

PRINCIPAL EQUIPMENT OF THE POWER PLANT OF THE CHESTER VALLEY ELECTRIC CO.

No.	Equipment	Type	Capacity	Size	Operating Conditions	Manufacturers
1	Main engine	Corliss	500 hp	24x36"	150 r.p.m., 150 lb. steam	Clark Bros. Co.
1	Main generator	Direct current	525 volts, 696 amp.		150 r.p.m.	General Electric Co.
4	Steam boilers	Water tube	125 hp		125 lb. steam	E. Keeler Co.
2	Steam boilers	Water tube	400 hp	4067 sq.ft.	150 lb. steam, 100 deg. superheat	Heine Safety Boiler Co.
2	Superheaters	Double box			100 deg. superheat	Heine Safety Boiler Co.
2	Furnace Grates	Shaking				Washburn & Granger
1	Steam turbine	Horizontal	625 k.v.a.		3,600 r.p.m., 150 lb. steam	Westinghouse Machine Co.
1	Steam turbine	Horizontal	940 k.v.a.		3,600 r.p.m., 150 lb. steam	Westinghouse Machine Co.
1	Turbo-generator	Alt. current	625 k.v.a., 2,400 volt.		3-phase, 60-cycle, 3,600 r.p.m.	Westinghouse Elec. & Mfg. Co.
1	Turbo-generator	Alt. current	940 k.v.a., 2,400 volt.		3-phase, 60 cycle, 3,600 r.p.m.	Westinghouse Elec. & Mfg. Co.
2	Condensers	Surface			28-in. vacuum	C. H. Wheeler Mfg. Co.
1	Cooling tower	Gravity				C. H. Wheeler Mfg. Co.
1	Feedwater heater	Open			210 deg. F.	Harrison Safety Boiler Works
2	Boiler feed pumps	Duplex		10x6x10 in.		Buffalo Steam Pump Co.
1	Rotary converter	Alt. and d.c.	200 kw., 600 d.c. vts.		3-phase, 60-cycle, 1,200 r.p.m.	Westinghouse Electric & Mfg. Co.
1	Generator	Direct current	35 kw., 550 volts		Driven by converter unit	Westinghouse Electric & Mfg. Co.
1	Generator exciter	Direct current	35 kw., 125 volts		Turbine driven, 3,500 r.p.m.	Westinghouse Electric & Mfg. Co.
1	Steam turbine	Single stage	35 kw.		150 steam, 3,500 r.p.m.	Westinghouse Machine Co.
1	Motor	Induction	30 hp., 2,200 volts		3-phase, 60-cycle, 1,130 r.p.m.	Westinghouse Electric & Mfg. Co.
1	Exciter generator	Direct current	20 kw., 125 volts		Motor driven, 1,130 r.p.m.	Westinghouse Electric & Mfg. Co.
1	Motor	Induction	75 hp., 2,300 volts		3 phase, 60-cycle, 1,175 r.p.m.	Triumph Electric Co.
1	Generator	Direct current	35 kw., 550 volts		Motor driven, 1,175 r.p.m.	Westinghouse Electric & Mfg. Co.

The Venturi Steam Meter

By Charles G. Richardson

SYNOPSIS—An explanation of the construction and operation of the venturi meter when used for measuring the flow of steam through a steam pipe. The rate of steam flow is indicated on a dial in pounds per hour at the moment of observation. A recording-chart dial furnishes an unbroken record of the rate of flow from hour to hour through the meter tube. A counter dial shows the total pounds of steam which have passed through the meter tube.

Twenty-six years ago, when the venturi meter was invented by Clemens Herschel, it was recognized that the same laws which were found to govern the flow of water through a venturi tube should apply equally well to gases. At that time, however, the demand for an accurate meter

Fig. 1. Outline of Meter Tube

for water supplied towns and cities through main pipe lines was preëminent and attention was concentrated upon the development of the venturi for such service.

In order to know whether a battery of boilers is performing its duty the amount of coal burned and water evaporated must be compared. Consequently, boiler tests have become more frequent than heretofore, but seldom are the results of such tests even approximately representative of daily operation. Nearly everyone concerned is eager at such time to make a good showing and thus the calibration is conducted under abnormally favorable conditions. Quoting the expert's figures, during a test the evaporation of pounds of water per pound of coal may be as high as 10, while under regular service the evaporation is frequently 5, averages 7 and rarely reaches 9 lb.

To meet the demand for a continuous check on the efficiency of steam production various types of coal weighers and water-measuring apparatus have been placed on the market. The venturi meter was early developed to measure boiler-feed water of high temperatures.

Many plants use large quantities of steam for manufacturing processes as well as for power. It, therefore, becomes highly important not only to know that the steam is being economically generated, but that an excessive loss is not taking place in the distribution to the various departments. Suspicion of such waste has little weight with department foremen as each points to the others as responsible, "if, indeed, there is any waste at all." Thus the investigator travels in a circle, arriving finally at the starting point, and is unable to prove his case. As a consequence, there has arisen a demand for a reliable steam meter, some of which indicate, by a pointer, the rate of steam in pounds per hour flowing at the moment of observation; others contain a chart upon which this rate is autographically recorded and from which the total pounds may be computed. Nearly all employ some form of a pitot tube projecting into the main pipe from which one or more small pressure pipes lead to the instrument.

It has been proved by a series of calibrations that the original ideas regarding the adaptability of the venturi meter for the measurement of gases were sound and it is the purpose of this article to describe the commercial apparatus.

When steam flows through a pipe contracted, as shown in Fig. 1, the pressure at the throat B is less than at the inlet A, due to the increased velocity at B. In a properly proportioned pipe this loss of pressure is almost entirely regained at the outlet C, which in turn is due to the decrease in velocity after the steam passes the throat. These facts may be proved by inserting pressure gages at A, B and C.

Practically the same amount of steam, therefore, will be delivered through such a tube as through a length of straight pipe of equal length and diameter under the same working pressure. The temporary loss of pressure at B can be accurately measured by a U-tube containing mercury and the difference in pressure between A and B bears a definite relation at all times to the rate of flow, or velocity, at B.

Meter Tube

The meter tube, Fig. 2, is made in several sections bolted together by flanged joints. The size is expressed by the diameter of the ends in inches, thus an 8-in. meter tube will properly fit into an 8-in. pipe line. Steam flows from left to right when the tube is in the position illustrated. At A, Fig. 1, is an annular chamber encircling the tube, called the inlet pressure chamber; at B is a similar chamber called the throat pressure chamber. Numerous vents open into the chambers from the interior and connections to the indicating or registering instrument are made at the tapped holes shown. The

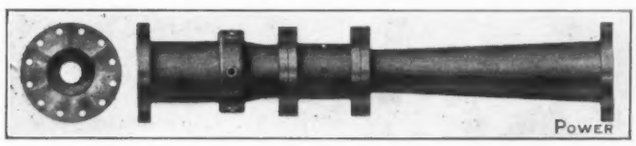


Fig. 2. Meter Tube

contour of the inside is similar to Fig. 1. The throat is lined with bronze. Calculations for rate of flow are based upon the throat diameter. The end view, Fig. 2, shows the entire absence of any inwardly projecting parts.

Manometer

Theoretically the simplest indicating instrument which could be employed with the meter tube would be a U-tube, one leg connecting with the inlet and the other with the throat pressure chamber of the former. Commercially the latest type of instrument is constructed, as illustrated by Fig. 3, on the principle of the barometer and consists essentially of a single glass tube projecting into a well containing mercury. The upper portion of the well is connected through the valve A to the inlet of the meter

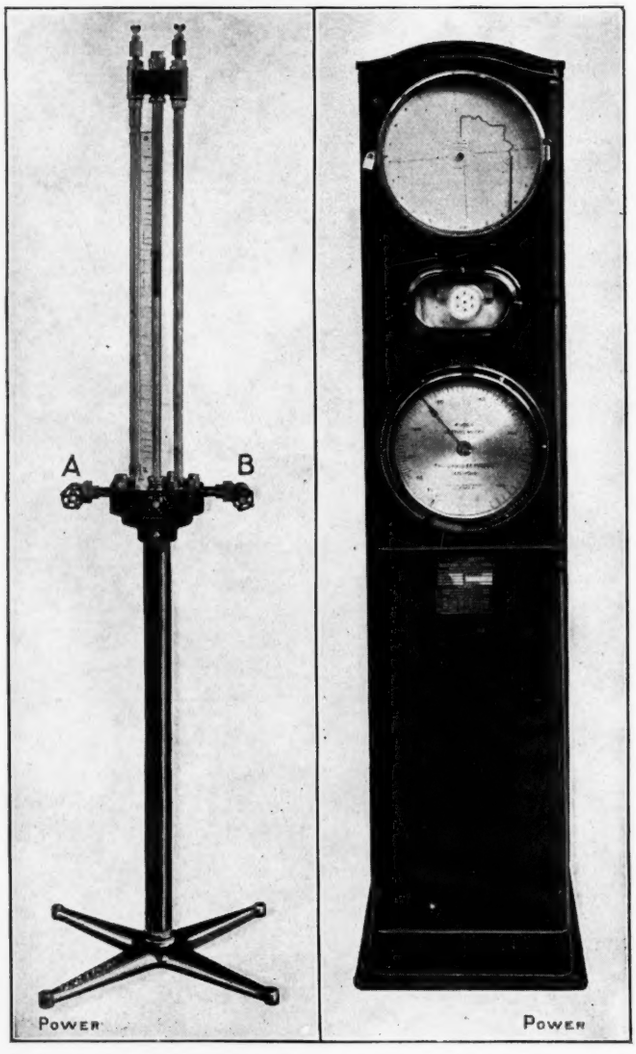


FIG. 3. MANOMETER. FIG. 4. TYPE M REGISTER-INDICATOR RECORDER

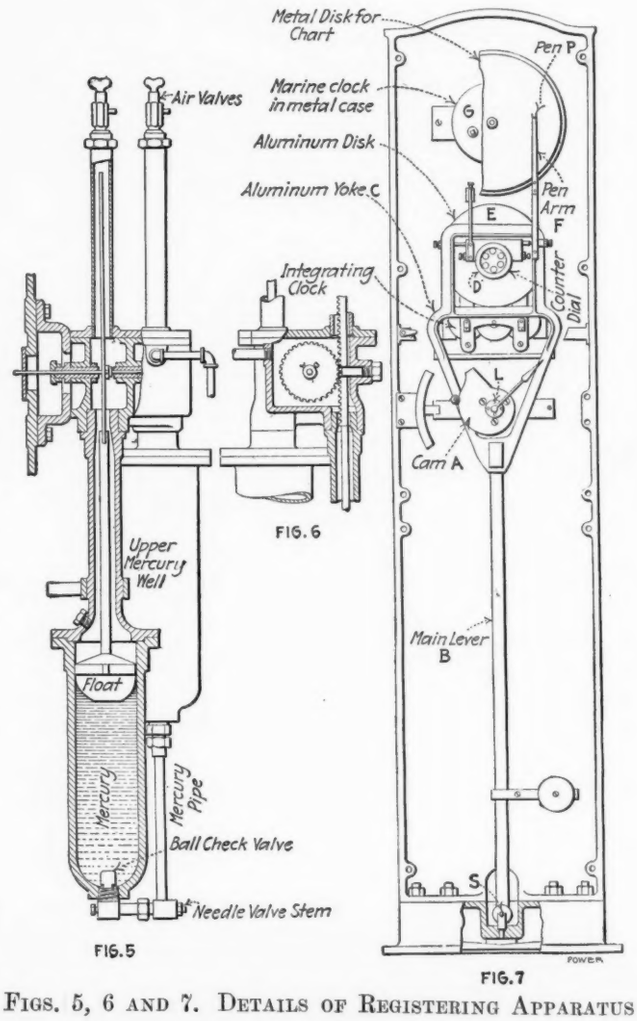
tube and the upper portion of the glass tube through the valve *B* to the throat of the meter tube. There is no flow of water or steam through the manometer and it contains no mechanism.

The rate of flow in pounds per hour, or other units, is read directly on the graduated scale shown at the left of the glass tube. Before starting operations this scale is so adjusted vertically that the zero line near the bottom comes opposite the top of the float resting on the mercury column. No further setting is necessary when taking readings, the fixed scale forming a distinctive feature of this instrument. The rate of flow is read opposite the top of the float, thus avoiding errors introduced in similar instruments by the mercury meniscus. The total quantity of steam is equal to the product of the average rate, obtained from periodic observations, and the elapsed time. By employing separate scales a single manometer may be used alternately with any number of meter tubes. For an occasional determination of the amount of steam supplied to the engine room and other departments of the plant, a meter tube may be placed permanently in each main line and the manometer, which is portable, used in connection with any one of these tubes as often as desired.

A new type of registering instrument, shown by Fig. 4, is called the Type M register-indicator recorder. This machine has three dials; the indicator dial shows the exact rate of flow in pounds per hour at the moment of observation. It is over 30 in. in circumference and can be read to ½ of 1 per cent. By observing the position of the dial hand the operating egnineer can throttle the flow to any desired rate. If required an additional hand, which can be set to any graduation mark, is supplied so that by regulating the steam valve in such a manner as to keep the two hands in alignment a definite steam supply is continuously maintained. Irregular steam flow and defective action of steam-taking units are revealed by oscillation of the dial hand.

The chart-recorder dial contains a circular chart approximately 12 in. in diameter which furnishes an unbroken record of the rate of flow from hour to hour through the meter tube. These charts form a daily record of all irregularities in steam consumption, whether due to normal demands or inefficient operation. The counter dial shows the total pounds of steam which have passed through the meter tube and is similar to the dial of an ordinary water meter.

Fig. 5 shows a section through one of the two mercury wells at the rear of the register. The two wells are connected at the bottom by a small pipe. Each well is filled with mercury to the level shown, and upon each mercury surface rests a float. The lower well is subjected to the inlet and the upper to the throat pressure of the meter



FIGS. 5, 6 AND 7. DETAILS OF REGISTERING APPARATUS

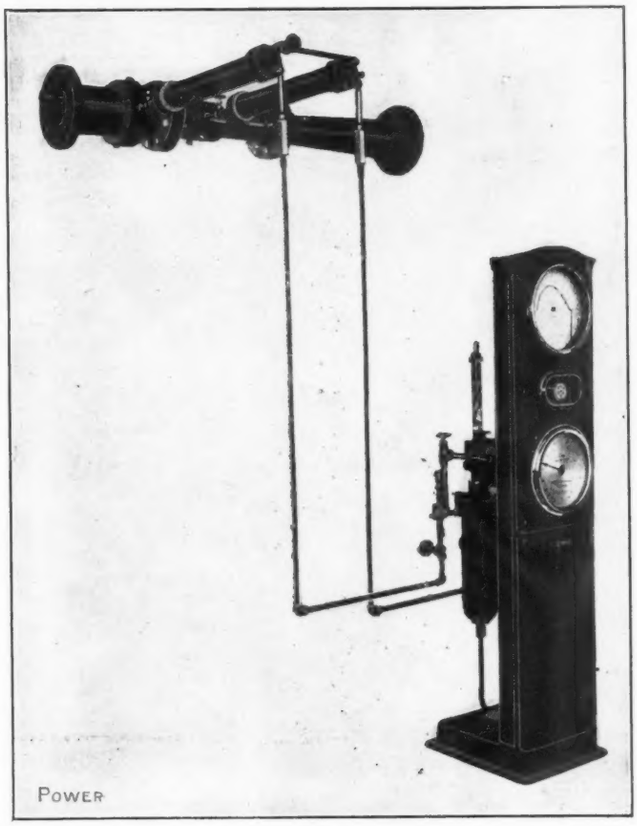


FIG. 8. METHOD OF INSTALLING METER

tube, so that a portion of the mercury is constantly being transferred from one well to the other in direct proportion to the difference in the two pressures. This causes one float to rise and the other to descend and such movement is transmitted through substantial rack and spur gearing to the main, or indicator-dial hand shaft, as illustrated by the sectional side view, Fig. 6.

The indicator-dial hand shaft *L* carries on its front end a cam *A*, Fig. 7. The cam controls the movements of a main lever *B* which is supported on two knife-edge bearings *S* and carries a yoke *C*. The counter dial *D* is actuated by a small roller which presses upon the aluminum disk *E* revolved at constant speed by a pendulum clock. The amount of movement of the counter-dial hands is therefore determined by the position of the roller on the disk. This particular type of integrating device was designed for use with earlier registering devices for water measurement. The aluminum yoke also carries pen arm *F* containing pen *P* which makes a continuous record of the rate of flow upon the circular chart revolved by a marine clock movement *G*.

In Fig. 8 is shown a typical arrangement of meter tube and registering instrument. Steam does not flow through the register; its readings are controlled by the difference in pressure at the inlet and throat of the meter tube as transmitted by the two small pipes. In each of these pressure pipes and close to the meter tube is placed a horizontal "condensing chamber" of simple construction, the purpose of which is to keep an equal head of water, or condensed steam, in both pressure pipes when variations in flow occur.

Fig. 9 illustrates an actual chart (reduced) obtained from a 3-in. meter in service in one of the power plants of a prominent electric-railway company. The steam was supplied to 14 fan blowers located under the boilers and which were automatically switched into or out of service by a single pressure-regulating valve controlled by the steam pressure in the main pipe. The irregular lines on the chart show the steam requirement when the blowers were running and also the frequency of operation. The regular lines *A*, *B* and *C* were made when the blowers were cut out, apparently recording a flow of steam amounting to 1400 lb. per hour. Actual investigation showed that the balanced controlling valve was leaking and could not be made tight. In other words, the venturi meter revealed a waste of steam amounting to approximately 34,000 lb. every 24 hours.

Among the more prominent advantages of the venturi steam meter the following claims are made:

The tube gives a very high difference in pressure between the inlet and throat, amounting to 10 lb. per sq.in. at the maximum capacity for which the meter is designed. Slight changes in rate of flow are consequently accompanied by comparatively large changes in differential pressure, allowing the registering device to be ruggedly constructed and avoiding all delicate parts or adjustments.

Steam flows only through the meter tube which contains a perfectly unobstructed passageway. Insertion of the meter tube in the main line does not, like an orifice, cause a drop in steam pressure.

The accuracy of operation of the registering device can be easily tested at any time by connecting the manometer into the two pressure lines shown by Fig. 8 and comparing the readings of the two instruments. The

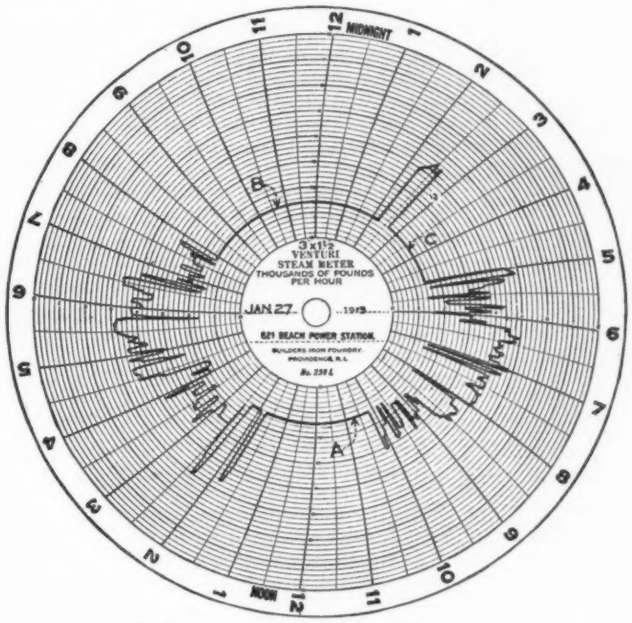


FIG. 9. A TYPICAL CHART

register furnishes three distinct kinds of information, each of which is of high value in improving and maintaining economical operation of the power plant. The meter has a wide range of capacity; thus an 8-in. meter will accurately measure all rates of flow between 8000 and 43,000 lb. per hour at 100 lb. gage pressure. It also automatically corrects for one-half the difference in density of steam for pressures other than for which the graduations are calculated.

Cooling Towers for the Power Plant

By Everard Brown

SYNOPSIS—Types and construction of towers, distribution of water and air, and principles of operation.

Cooling towers have been in use commercially in this country for about twenty years. It is only within the past few years, however, that they have met with any great encouragement, and this has been due mostly to the advent of the steam turbine, particularly the low-pressure type. In fact, it might almost be said that in many localities where the quantity of water is limited, the cooling tower has made the use of condensing machinery possible. This fact is perhaps more greatly emphasized in connection with exhaust or low-pressure steam turbines which require high vacuums in order to get maximum output at minimum cost. There are, no doubt, many installations in existence today running condensing as a result of the cooling tower.

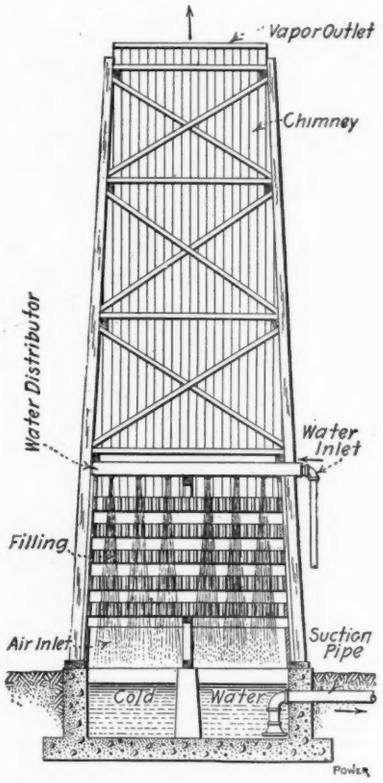
As a rule each installation of cooling towers must be treated separately because of climatic conditions; therefore, no general formula can be laid down for towers of varying capacities that would be applicable to all localities. It might be stated in a general way, however, that localities best suited to their use are those possessing a dry climate. The two most potent factors that enter in to the proper design and size of an installation are temperature and humidity of the atmosphere.

The function of a cooling tower is to dissipate the heat in the ingoing water to the atmosphere and its general principles are to some extent the reverse from those embodied in the condenser. Its efficiency, therefore, depends entirely upon the amount of heat extracted from each pound of water at a minimum cost for fixed and operating charges, consequently its design and construction should be such that a most intimate contact will be obtained between the water and the air. The heat in the water is extracted in two ways, namely: by supplying the latent heat for vaporization and by heating the air passing through the tower. The first of these removes the greater portion of the heat.

Water Vapor Absorbed by Air

The amount of water vapor which can be absorbed by any given volume of air depends upon its temperature and the amount of water present in the air originally. Also any increase in the temperature of the air naturally increases its water-absorbing capacity. The term, relative humidity, is the ratio of the water vapor in the air to the water vapor it contains when saturated. Now, for example, suppose that in a certain locality the average relative humidity is 72 per cent. and the average temperature is 52 deg., then the average weight of water per pound of air is approximately 0.006 lb. If the humidity is increased to 100 per cent. and the air is at the same temperature, then the weight of water per pound of air is about 0.008 lb. Therefore, if a pound of this air passes over water and becomes saturated it can take up 0.002 lb. of water in the form of vapor and thus reduce the temperature of one pound of water approximately 2 deg. In addition to this abstraction of 2 B.t.u., the increase in the temperature of the air as it rises in the tower gives it a larger vapor-absorbing capacity per unit of quantity so that its capacity would be about 0.044 lb. if it were heated, say, 100 deg., thus representing an abstraction of 2 deg. from approximately 19 lb. of water.

It can readily be seen, therefore, why a closed tower is more effective than an open one and that the hotter the water discharged by the condenser, the hotter will be the rising current of air, and, consequently, the greater will be its capacity for taking up moisture and abstracting heat. It is also evident that the less moisture there



General Design of Cooling Tower

is in the ingoing air the greater will be its absorbing powers, which accounts for the fact that cooling towers are more suitable for a dry than a wet climate. At many installations a large cloud of vapor may be noticed hovering over the tower, which might possibly be drawn down into it again and thus reduce its effectiveness. Under such circumstances it may be advisable to provide a reasonably high stack to carry off this vapor.

The air leaving the tower should, of course, be as nearly saturated as possible, and this can be accomplished only by getting the most intimate contact between it and the water. In order to get the best results from an economical viewpoint, there should also be a fixed relationship between the condenser and cooling tower as to temperatures as well as between the quantities of all air and water entering the tower. It is on these relationships that the proper design and size of the tower is based. For example, the manufacturer will guarantee a difference in temperatures between the ingoing and out-

going water of the tower of, say, 25 deg., or from 120 to 95 deg., at a certain wet-bulb temperature. This, however, does not mean that the same reduction of 25 deg. will result with water entering at 100 or 115 deg., even though all other conditions remain the same. The calculations in this case are all based on ingoing water at 120 deg., and the amount of cooling surface in the tower is governed accordingly. This means, that there are certain conditions upon which a cooling-tower guarantee of performance is based, namely: quantity of water handled, initial temperature of this water and wet-bulb temperature. The first two of these can be largely controlled, but the third is a variable that may change at any time. So, it is apparent that the conditions under which the guarantee is made are met with only at times and then only can the range of water temperature guaranteed be obtained. It might be interesting to note, however, that there are records of some installations where the temperature of the water has been lowered below that of the atmosphere. This, of course, is the result of the heat abstraction due to vaporization.

Types of Cooling Tower

Cooling towers are made in many different forms, such as round, square, rectangular, octagonal, etc., although the round and square ones are probably the most common. The shell is made either of wood or metal, usually at the option of the purchaser. A shell made of a good grade of swamp cypress will probably last as long if not longer than one of steel, especially if the wood is first treated with some good wood preservative. A steel shell should be well painted both before and after erection in order to protect it from corrosion. The wood is perhaps slightly cheaper and the steel requires somewhat less ground space, otherwise the advantages of the one over the other are practically negligible. The filling usually consists of boards or strips of swamp cypress, geometrically arranged so as to insure complete and ultimate distribution of the water and the air. The arrangement should also be such that there will be the least possible frictional resistance to the air circulation, thus reducing to a minimum the power required to operate the fans and at the same time permitting the flow of a larger volume of air through the tower, such as might be necessary in the case of a temporary overload. Perforated iron or steel mats, wire nets, tile or metal tubing, cloth, etc., are also used quite extensively for the same purpose. In all cases, however, the same precaution should be taken to get good distribution with as little resistance as possible because both of these are very essential to the best operation of the tower. Some objection has been raised to the mat or cloth filling because dirt and possibly oil from the cylinders of the engines are apt to clog up the small openings in the mats and cling to the surface of the cloth so that the water will not become so finely divided, but will descend in more or less large films or streams, which, of course, is inimical to high efficiency. To overcome this difficulty, at least to some extent, such fillings are so designed that the mats or cloth can be removed in sections for the purpose of cleaning without interrupting in any way the operation of the tower. All fillings, irrespective of design and material, should be self-supporting and practically independent of the shell.

Distribution of Water

Another important factor that must receive due consideration is the even distribution of the water at the top of the tower. There are several types of distributors for this purpose, all of which no doubt have, at least some merits. Of these various types there are two that seem to enjoy the greatest popularity. One of these is simply a flume on the side of the tower which feeds a number of small troughs that are laid across the top of the filling. These troughs are perforated with many comparatively small holes and if there are a sufficient number of troughs, a pretty even distribution may be expected. The other method of distributing the water is by means of a revolving hub to which a number of pieces of pipe are radially attached in a way similar to the spokes of a wheel. These pipes or spokes are perforated along one side only so that when the water is introduced it causes a revolving action due to the force of the jets from each of the perforations. The apparatus is simply a large lawn sprinkler that throws the water out radially instead of upward. Because of its shape and revolving motion it is best suited to round towers.

Air Supply

A forced-draft tower, as its name implies, depends upon one or more large fans, generally located near the base to create the draft. It should be fully enclosed around the bottom with the exception of the fan openings so that the only egress for the air is up through the filling and out of the top of the tower. This type does not require a stack unless it be for the purpose of carrying off the vapors so that they cannot be again drawn in by the fans at the bottom. There is another type of forced draft tower in which a single fan is located horizontally at the top of the tower which draws the air in at the bottom, up through the tower and then forces it through a short stack which, with such a construction, is essential. In this case there is an open space all around the bottom of the tower to admit the air freely. Usually the shell and filling are supported on deep steel or concrete girders that extend across the rest on the walls of the sump, thus leaving an opening all around equal in height to the depth of these girders. This horizontal type of fan is usually driven by means of a pelton wheel, also located horizontally, at the top and just beside the fan. Both the fan and the pelton wheel driving it are supported by an hydraulic step bearing. A design of this kind has the advantage that it requires nothing but water for its entire operation, whereas the other type with the vertical fans at the base usually have motors to operate the fans. It is questionable, however, whether there is any saving in power with the single fan at the top over the regular motor-driven fans, as the water to operate it must be pumped to a considerable height. It is also questionable if as good a distribution of the air is obtained. The actual amount of power required to operate fans for either type, depends upon too many variables that govern the quantity of air required in order to get the most economical results to permit of any standard rule or even much of a predetermination for any particular installation. Calculations should, of course, be made in order to determine as nearly as possible the size of drive required, but they can only be made for the individual installation under consideration.

The natural-draft tower is similar to the forced-draft except that a relatively high stack is required and that plenty of space must be allowed for the air to enter at the bottom. Not having any fans, it is naturally a less expensive installation both as to initial and operating costs. A larger cooling surface is necessary, however, which means that more ground space is used as it is hardly advisable to build the structure very high on account of the large head against which the water must be pumped. Its operation will be more variable than with the forced-draft type, because of its dependence only upon the natural rising action of the heated air for its draft, consequently, when the weather is not favorable, the results in the tower will be likewise. Europe seems to be quite partial to this type of tower, due, perhaps, to its low initial cost and freedom from much care and attendance, while in this country the reverse seems to obtain, the idea being to get the maximum results possible under all weather conditions even at an increased expenditure of money, if necessary.

Homemade Tower

To all appearances a cooling tower is quite a simple affair, which fact has led many to erect a so called "homemade tower." Usually the results obtained, however, are not very satisfactory. While there is really no valid reason why such installations should not answer the purpose, yet they do not seem to come up to expectations, probably because the problem looked so easy that sufficient care was not exercised in the design. There are, of course, many patents covering certain forms of construction which prohibit their use without permission, and many of these have been thoroughly demonstrated and shown to properly perform the function required of them. Furthermore a great deal of time and money have been expended by cooling-tower manufacturers in perfecting their product, of which the builder of a homemade tower would get no benefit. It is also questionable whether there would be any great money saving in the end.

Four Essentials in Design

To insure a high profit upon the investment, the design of a cooling tower must comply with four essentials and these are: low initial cost, low operating cost, large cooling capacity and cooling range, and small ground area.

The fourth item is important only when the tower is to be placed upon a roof or where the ground area is limited or expensive. If these essentials are carefully borne in mind when designing the tower there is but slight possibility of failure even with a homemade one.

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Pneumatic Cylinder-Packing Leathers

By F. W. Bentley, Jr.

SYNOPSIS—Directions are given for replacing pneumatic cylinder packing, showing defects resulting from some methods employed and how to eliminate them.

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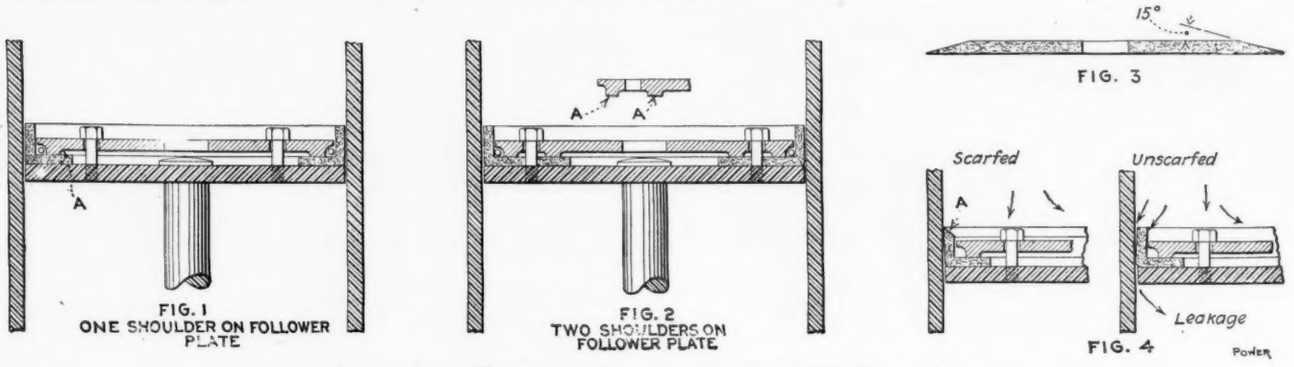
Ever since compressed air has been used to operate hoists, brakes and other labor-saving devices, the general utility of leather for a cylinder packing in connection with them has never lessened. The soft pliable nature of leather and its great fibrous strength enable it to effectively retain compressed air. But leather does not completely cover the requirements of a cylinder packing when used for compressed air, and in many instances but little attention is given to the manner in which the leather is prepared and applied to the piston and cylinder. This, nevertheless, has a more direct bearing on the life and utility of the leather than almost any other condition imposed upon it.

Putting in a new cylinder leather does not require extraordinary mechanical ability, but when viewed from the standpoint of durability and service, as much care should be given to this work as to the repair of the most costly machinery in the engine room. The aim of this article is to bring out a few points, sometimes not considered, which directly tend to maintain the leather in perfect and efficient working condition as long as possible.



Details of Follower Plates and Packing Leathers

A packing leather is generally secured to the head of the cylinder piston by variously constructed follower plates. The most common type of follower is that shown by the cross-section, Fig. 1. The circular shoulder *A*, on the under side of the plate, is to force the leather tightly against the top of the piston head to form an air-tight union between it and the plate. The fault of this plate is its weakness, when made of cast iron, for the slight

leverage caused by the draw of the bolt inside the circular shoulder is often sufficient to break the follower.

This difficulty, in spite of the inherent brittleness of cast iron, can be overcome by using a follower having two circular bosses, allowing the follower studs to go through the plate between them, as *AA*, Fig. 2. The compressive draw of the stud nuts is evenly distributed between the two bosses. Its construction necessitates using a wider leather, which is an advantage, as the leather is necessarily cut and fitted over the plate studs and cannot work out from the follower when tightened.

The packing leather, however, is the vital part of any pneumatic device possessing an air cylinder, and there are a few points in connection with the preparation of the leather, and its application to the piston head which, if heeded, will tend to greatly increase the efficiency of the leather. The commercial leather most commonly used for air-cylinder packing generally has one side of the material finished, which hardens its surface and destroys the porosity of the leather. The side known as the flesh side is porous and should come in contact with the cylinder walls, as it is pliable and can readily fill any irregularity or slight cut in the cylinder. The flesh side of the leather will more readily absorb and retain any lubricant put into the cylinder to prevent the wear of the leather and to assist in maintaining its pliability.

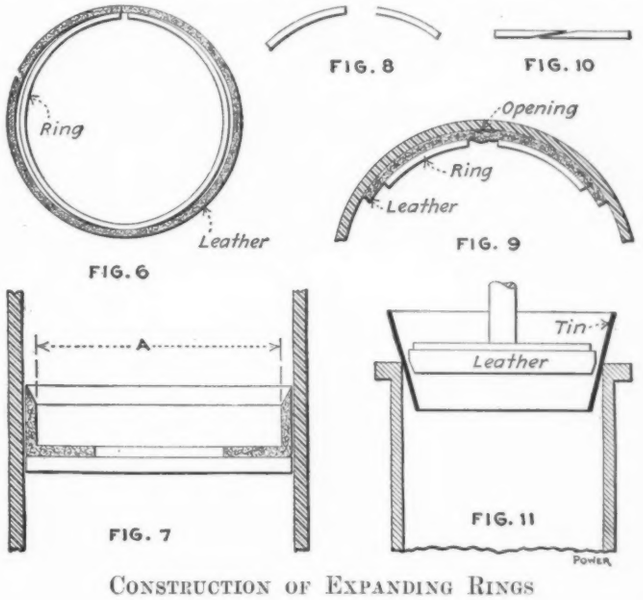
In many instances the packing leather is fastened to the piston head and drawn into the cylinder with no provision made to overcome cramping, for compression, as a result of forcing it into the cylinder, will cause parts of the leather to bend over and away from the cylinder walls. The rigidity of these parts in this position makes it difficult for even a very strong air pressure to force the leather against the cylinder and air leakage results.

FIG. 5. SCARFING A LEATHER

This difficulty can be overcome by scarfing the upper inner side of the leather to a thin edge, Fig. 3, and at *A*, Fig. 4. The air can then more easily force the leather against the walls of the cylinder and make the packing air-tight. The arrows, Fig. 4, also show the action of the air on the thick edge of an unscarfed leather, and how the thin edge of a scarfed leather is more easily thrown against the sides of the cylinder.

In Fig. 5 the edge of the leather is illustrated, held even with the side of some metallic surface and scarfed by turning the leather at each draw of the knife. The required angle of the scarf is easily kept during the cut by pressing the knife blade against the edge of the surface on which the leather is held.

Expander rings should be given special attention. Often these rings are rolled and set with too large an outside diameter, and then forced to enter the inside of the upturned part of the leather by cutting a piece off the ends. This is radically wrong, for it produces an elliptical-shaped ring which bears upon the leather at two points only, namely, at the ring opening and directly across from it at the swell of the circle. The leather consequently wears more quickly at these points and the rest of it



CONSTRUCTION OF EXPANDING RINGS

has only a slight contact with the cylinder walls. Fig. 6 is an exaggerated view to make this clear. The ring should be rolled to an outside diameter only a trifle larger than the inside diameter of the upturned part of the leather, as shown at *A*, Fig. 7.

Another important point in connection with the construction of the expander ring is the nature of the break or opening in the ring itself. Frequently the two ends of the ring are cut squarely across, as in Fig. 8. Should the diameter of the ring be a trifle too large or should the ring happen to have an undue amount of spring and an excessive opening, a part of the leather would not press against the walls of the cylinder, Fig. 9.

The most desirable and practical way to prepare the opening of the ring is to scarf the ends, allowing them to overlap. This can be done before the extra stock on the ends is removed after rolling, as in Fig. 10. This permits the expander to come in contact with the leather and press it outward at every point.

Often in hoists of the upward-pull type, due to their construction, the leather cannot be drawn into the cylinder, but must be compressed or forced into the mouth of the cylinder barrel. Fig. 11 shows how a rectangular piece of tin or sheet metal can be placed around the inside mouth of the cylinder, something after the style of a funnel. The piston head with the attached leather is then drifted into the cylinder. The leather cannot squeeze out at any point as it often does when the attempt is made to start or drift it with thin-edged chisels. The tin is easily withdrawn with a pair of knurled tip pliers, should it drift into the cylinder with the leather.

Standardization of Boiler-Stoker Installations*

By Joseph G. Worker

This paper has been prepared as a plea for the standardization of a better practice in the installation of boilers and stokers. This higher standard must be attained so that a practice may be established in the different cities that will conduce to a more smokeless operation of plants, independent of any boiler or stoker.

Today the people to blame for the smoke nuisance are the manufacturers of boilers and stokers, the purchaser who buys and operates the equipment, the consulting engineers and architects, the smoke inspectors. It cannot be stated that any one is more responsible than another. It makes no difference whether or not the boiler and stoker manufacturers present a smokeless combination, the installation can be ruined, insofar as the abatement of smoke is concerned, by the purchaser and operator. In order to correctly place the responsibility, it is necessary to analyze each installation separately.

There have been some improvements in recent years in the matter of boiler and stoker combinations. Boilers have been raised somewhat; stokers have been set differently; more attention has been given to the breeching design and higher stacks are being used. Still there has never been anything like the thought on this subject that there should be and the standardization of the practice that is necessary. There is need of an analysis of installations and the information should be translated into good data that can be distributed with confidence.

When a stoker is installed in combination with a boiler, there are many things that must be considered and decided jointly by the purchaser, the boiler and stoker manufacturer and the smoke inspector.

Height of the boiler header above the floor line or height of boiler setting, setting of the stoker, combustion space necessary for the coal to be used, design and location of the breeching, size and location of the stack, area of gas passages through the boiler, area of damper openings, facilities for cleaning soot off of boiler baffles and boiler tubes.

Other things that should be considered as affecting the reliability of the equipment are:

Grade of firebrick to be used in the furnace construction, size of walls of boiler and furnace setting, size and grade of firebrick for arches, if used; method used to control dampers, construction of ashpit and facilities for disposing of the ash, method of conveying coal to the stoker hoppers.

Referring to the foregoing items, if the purchaser failed to install the height of stack that was necessary, he would be the one that was responsible for the installation's failure. If the stoker manufacturer did not insist upon correct setting of the stoker, he would be responsible. If the boiler manufacturer failed to provide the correct areas for the passage of the furnace gases and arrange to set the boiler at a height required for the particular stoker selected, he would be responsible.

One frequently hears that boilers cannot be set higher because the contract for the masonry work has been included with the boilers; or, that the contract has already been let and the purchaser will not pay the extra cost of properly setting the boilers with the stoker selected. Again, we frequently hear that the boilers cannot be set right because the architect has previously provided so much room for the boiler and stoker and they must go within the limit provided whether a good or bad combination is obtained.

There is another phase of this problem that seems at the present to interfere with obtaining good installations, that is, the cost of the installation. Of course, boilers being raised, stokers extended, higher stacks, etc., cost more money. The boiler and stoker manufacturers and the smoke inspectors should, however, take a sufficiently firm stand for the combinations that are known to be right and be sure that enough money is expended to make them right.

What is needed is an organization that has for its object the diffusion of information and data on installations made to burn bituminous coal without smoke. Committees should be appointed to investigate and analyze installations of all kinds in all territories. For example—a committee consisting of members who live in the vicinity of Cleveland could take four or five different kinds of combinations in that locality from the time that they are installed and report to the organization everything that entered into the construction and design. Drawings and data could be presented that would determine what the particular installation would do in the abatement of smoke. The time has not come when a combination can be standardized in the West and be adapted to the conditions in the East, or *vice versa,* with success. There should be, however, one society from which all the data would emanate.

After the boiler and stoker have been selected, it is not yet time to finally decide whether or not these particular types should be purchased—it is not the time to sign the contracts. The purchaser should arrange a conference between the manufacturer of the boiler, the manufacturer of the stoker, the smoke inspector, if there is one, and himself. The whole combination and the things mentioned in the forepart of this paper should be discussed in detail and a decision made on each matter. The purchaser should not obtain an opinion from the boiler manufacturer as to how the boiler should be set unless he gives the stoker manufacturer an opportunity to present his opinions. If all points are settled on a good engineering basis, the best combination known will be obtained and the customer can well afford to expend the money necessary for it.

[Editorial reference to this paper is made on page 511 of this issue.—Editor.]

*Read before the International Association for Prevention of Smoke at its 8th annual convention, Pittsburgh, Penn., Sept. 9-12, 1913.

Power Generation and Hydraulicking are accomplished with the same water at the Pioneer tin mine in Tasmania. The powerhouse is situated 300 ft. above the mine and generates electric current by the means of impulse turbines operating under a head of 189 lb. per sq.in. During the six months ended Dec. 31, 1912, the mean power load was 482 kw. The power is transmitted at 6500 volts to the mine, and the water after leaving the turbines is conveyed 4¼ m. to a point 240 ft. above the mine, where it is available for use in the pipe lines to the hydraulicking giants.

ELECTRICAL DEPARTMENT

The Tirrell Regulator

By John A. Randolph

On all distribution systems, whether supplied by direct or alternating current, it is of vital importance that the voltage be maintained constant. There are several reasons for this: First, it has been found that the life of incandescent lamps is materially shortened by a fluctuating voltage, especially if it has a tendency to rise higher than normal; this renders lamp renewals more frequent. Moreover, an unsteady or variable pressure causes a variation in the intensity of illumination which is likely to result in dissatisfaction upon the part of the consumer. If the potential assumes values below normal for appreciable intervals of time, a loss in revenue to the station will ensue, owing to a decrease in the number of watt-hours supplied. Another disadvantage arises from the variation in speed and torque of motors suppplied by the system. This condition temporarily affects their efficiency and produces unsatisfactory results in the operation of the appliances to which they are attached. In view of the foregoing disadvantages and many others, careful attention is given to the maintenance of a constant voltage on all uptodate light and power systems.

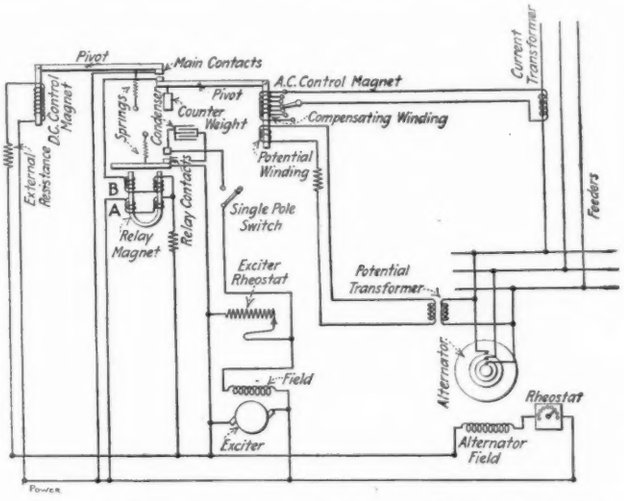


Fig. 1. Connections for Three-Phase Circuit

Various methods are employed for regulating potential. One of these consists in the adjustment of the pressure on the indivdual feeders. In another method, the regulation is effected at the generator. The latter practice is in most general use.

There are several means used in regulating generator voltage. The nature of these depends primarily upon whether the machine is of the alternating- or direct-current type.

The potential of alternating-current generators is regulated in various ways, the choice depending largely upon the capacity of the generator, the number of other machines in the station, the facilities for excitation and the method of drive, that is, whether by belt or direct connection. The methods most commonly used in this country consist of separate excitation, composite excitation and by an automatic regulator. In the first method, the voltage is maintained constant by varying the alternator field current with rheostats placed in both the exciter and main field circuits. The rheostats are also used in the composite method but, in addition, a part of the current from the alternator armature is rectified and sent through a compounding coil on the generator field. This produces a compensating effect which varies in conformity with the loads on the machine. The third method employs an automatic regulator, the leading form of which will be described presently.

On direct-current machines, the regulation is effected by rheostat control, compounding, and by devices that regulate the field current in the generator or exciter automatically.

Where the control is by hand, there is a disadvantage in that time is required of the attendant which could otherwise be devoted to other duties. Moreover, the steadiness of the voltage is to a certain extent dependent upon the personal watchfulness of the operator. Therefore, to eliminate the personal element and to produce a steadier voltage, the automatic regulator was devised.

Use on Alternating-Current Systems

There are several automatic devices in use for alternating-current potential regulation, but the one which has given the most general satisfaction is the Tirrell regulator. This device accomplishes its result by short-circuiting the field rheostat of the exciter when the voltage of the alternator is too low and opening the short-circuit again when the potential has risen sufficiently. So rapidly is this done that no appreciable fluctuations in the pressure are noticeable.

The device, as fundamentally constructed for alternating-current work, consists of two solenoid magnets and a relay as shown in Fig. 1. One of the magnets is operated purely by direct current and is connected through an external resistance directly across the exciter busbars. The core is free to move and actuates a lever carrying at one end a contact. The other solenoid is excited by alternating current and contains two windings, one of which is connected across two of the generator mains by means of a potential transformer. The other winding compensates for variable currents and is connected to a current transformer carried on one leg of the circuit. This solenoid, like the other, actuates a lever with a contact.

The relay consists of a U-shaped stationary iron core carrying two opposing windings *A* and *B*, and a movable armature actuating two contacts; the windings receive direct current from the exciter busbars. The current in coil *A* is continuous, but that in coil *B*, controlled by the main contacts, is intermittent. The relay contacts are so connected across the exciter rheostat that the latter is completely short-circuited when the contacts are closed.

The condenser is for reducing the arcing at the relay contacts.

Operation

When placing the regulator in operation, the single-pole switch in the rheostat short-circuiting lead is opened. The rheostat resistance is then turned into the exciter field circuit until the voltage of the alternator is reduced about 65 per cent. below normal. The lowered potential of the exciter weakens the magnetic effort exerted by the direct-current solenoid upon its plunger, with the result that it is overcome by the springs at the opposite end of the lever; the upper main contact is consequently pulled downward. The attractive power of the alternating-current solenoid is likewise decreased, and its core falls and allows the lower main contact to rise until it meets the upper contact.

The closing of the main contacts energizes the relay coil *B* whose field in turn neutralizes that of coil *A*, thus demagnetizing the relay and allowing the spring to draw the armature upward and close the relay contacts. The single-pole switch is now closed. This at once raises the voltage of the exciter inasmuch as the rheostat is short-circuited, all regulating resistance being thereby removed from the field circuit. The increased pressure of the exciter acts directly upon the generator field, raising the

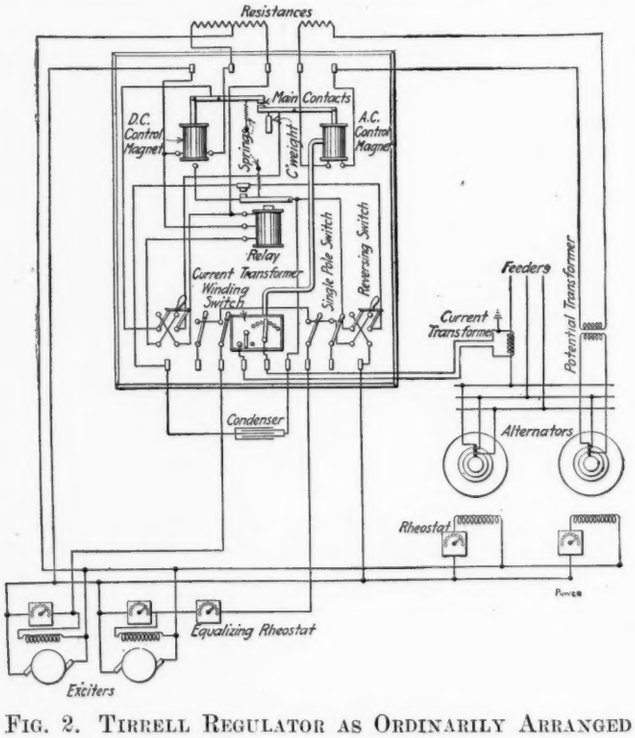


Fig. 2. Tirrell Regulator as Ordinarily Arranged on Alternating-Current Switchboard

alternating-current potential in consequence. When the voltage has reached the proper value, the two control magnets are sufficiently energized to overcome the resistances acting against them and accordingly open the main contacts. This causes the circuit through relay coil *B* to open. Coil *A* being now no longer opposed, energizes the relay core and attracts the armature downward, opening the relay contacts and temporarily removing the short-circuit from the exciter field rheostat. The latter being now cut into service, lowers the voltage until the two control magnets again close the main contacts and thereby raise the pressure. In practice, this cycle of operations takes place so rapidly that it is best described as a high rate of vibration upon the part of the contact elements. The resulting voltage is not necessarily constant, but is steady.

In Fig. 2 are shown the connections and relative locations of the component parts of the Tirrell regulator used in alternating-current work, as they exist in practice. It will be observed that the hand-operated switches are lo-

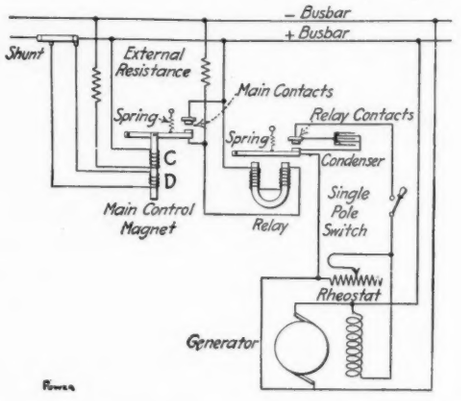


Fig. 3. Arrangement with Direct-Current Generator

cated in a convenient position at the bottom of the instrument. The connections here shown represent the method used where the instrument is employed for regulating the voltage on two or more generators operating in parallel, the exciters being also in parallel. By tracing the respective circuits it will be observed that the same general scheme of connections is used as is shown in the simplified diagram of Fig. 1. The double-pole, double-throw switches shown in Fig. 2 are for reversing the direct current in the circuits which they control. This is to furnish more flexibility in the handling of the instrument for testing and other conditions where a reversal of current may be required. The resistances shown at the top of the figure are contained in a well ventilated rectangular case located on the back of the switchboard panel and directly behind the regulator proper. The leads from the resistances to the regulator are connected to the latter through terminals at the top of the instrument, as shown. The other external connections are made through terminals at both the top and bottom of the instrument. The multiple-point switch shown at the bottom is for adjusting the number of active ampere-turns in the compensating or current-transformer winding of the alternating-current control magnet.

The automatic portions of the regulator are inclosed in a rectangular glass case, but the switches and terminals are left exposed for convenience in operation.

Use on Direct-Current System

The Tirrell regulator used for direct-current voltage regulation is similar in construction and operation to the form used with alternating currents. The fundamental diagram of connections is shown in Fig. 3. The main elements consist of a control magnet and a relay, the former having two opposing coils *C* and *D*. The winding *C* is connected through an external resistance across the main busbars, and the winding *D* is connected to an ad-

justable shunt carried either on one of the main busbars or on a feeder. The core of the magnet is movable and actuates a lever controlling two contacts. The relay has a U-shaped core with a winding connected through a resistance across the main busbars. By means of an iron-bar armature, it controls two make-and-break contacts in a circuit which, when closed, short-circuits the generator field rheostat. The arcing at the relay contacts is reduced by a condenser.

Operation of Direct-Current Regulator

The method of starting the direct-current regulator is very similar to that employed with the alternating-current instrument. The single-pole switch in the field rheostat short-circuiting lead is first opened, the resistance of the rheostat then being turned in until the voltage is brought to a value about 65 per cent. below normal. This weakens the excitation of the main control magnet to such a degree that the magnetic attraction on the plunger is overcome by the spring on the contact lever. The lever is consequently pulled upward, thereby forcing the main contacts together and shunting the relay winding. This causes the relay to lose its attractive force, with the result that its armature is pulled upward by its spring, the relay contacts being consequently closed. The single-pole switch is now closed. The rheostat now being completely short-circuited, the voltage at once rises because of the increased field excitation. With the rising potential an increasing current is caused to flow through the control-magnet winding *C*. When the pressure has reached the proper value, the main contact lever is drawn downward, opening the main control circuit. The relay is now energized, attracts its armature and thereby opens its contacts. The latter action places the field rheostat again in circuit, with the result that the voltage is lowered until the magnet and relay again cause it to rise. The opening and closing action of the contacts is vibratory and therefore maintains a steady voltage on the system.

The winding *D* on the main control magnet is for the purpose of delaying the action of winding *C* to an extent depending upon the current supplied by the generator. Heavy currents necessarily require a higher voltage at the busbars than those of lower value because of line drop. The voltage drop across the shunt in the main circuit varies with the strength of current, the result being that the action of winding *D* in opposing winding *C* is varied accordingly. The greater the excitation of winding *D* the longer will be the delay in the opening of the main contacts.

High-Tension Distribution by One-Wire Grounded System*

Single-wire transmission of electric current is one of the earliest forms of transmission and holds possibilities for securing rural business, due to its low cost. The Benton Harbor Co., studying along these lines, found that the only solution would be a grounded return primary distribution, giving single-phase current on a single wire and three-phase current on two wires. But as this would give a dead ground with the entire generating and transmission system, it became necessary to devise some means that would give immunity from grounds on the one hand and allow a permanent ground on the other. This can be accomplished very nicely by a 1:1 transformer, or if the rural lines are to be very long, a 1:2 transformation can be employed, giving a 4600-volt single-wire from a 2300-volt two-wire line.

About a year ago the company made arrangements to build such a line. Two commercial transformers with secondaries connected together, provided the necessary insulation between the rural and city lines. The single-wire line was built under adverse conditions, and is approximately 2.5 miles long. Triple-braided weather-proof wire has been used throughout the system both for primary and secondaries. The latter are not grounded in this system; in fact, all efforts possible were made to prevent the grounding. Lightning arresters are placed on the line at every transformer. Fuses are placed between the transformers and the ground and between the primary wire and ground. The grounded wire of the primary side is a No. 4 rubber-covered wire, which is nailed to the pole and covered with special wood mold in going to the ground and connecting with a 24-in. copper ground cone buried in moist earth with one sack of charcoal around the cone.

So far, the company is thoroughly satisfied and believes that on a properly constructed line on private right-of-way, thus getting away from heavy trees, a line can be built much cheaper than on the standard two-wire construction with less danger from high winds, sleet and other line troubles. A line of this character can be built for approximately $228 per mile as compared with $380 per mile where two wires are used.

*From a paper by John A. Cavanaugh, delivered at a recent meeting of the Michigan Section, National Electric Light Association.

Stator Not Properly Aligned

While employed several years ago as engineer in a steam-electric plant, one of our 1000-kw. engine-generators was so damaged by lightning coming in on the feeders as to make necessary the renewal of stator coils and shifting the stator to one side for access to the coils.

After repairs had been made, the stator was jacked back into position and bolted down; the engine was started, and the field current thrown on. Immediately a loud rasping or scraping noise was heard and the field current had to be taken off quickly, when the noise ceased.

Upon examination, it was found that the stator had been pulled over by the field current, causing the scraping noise. The erector had neglected to dowel the stator to its sole plate and since we could not seem to hold it in place, on account of the holding-down bolts not fitting, we left the jack and blocks in place, holding it by bracing from the engine-room wall. This answered for temporary use, until we could get the dowels in.

B. W. Dennis.

Columbus, Ohio.

Canadian Electric Transmission—Power will be delivered to the city of Windsor in the early spring if the present plans of the Hydro-electric Power Commission materialize, according to the Toronto "Globe." The right-of-way for the line from Chatham to St. Thomas has been selected. The line will run from Chatham to Ridgetown, and from there along the south side of the Pere Marquette Railway to St. Thomas. The St. Thomas to Windsor line will stretch over a distance of 112 miles.

GAS POWER DEPARTMENT

The Oil-Motor Industry in Italy*

The employment of large internal-combustion engines in Italy, which is now flourishing, hitherto depended for the most part upon imported machines. The manufacture of small high-speed benzine and petroleum motors has been successfully carried on by domestic shops for some years but as regards the building of heavy oil engines, Italy has just passed the experimental stage.

The first stationary Diesel engines of high power and Italian make were built by Franco Tosi, of Leghorn, who has recently been at work on marine engines of his own design. For five tank vessels under construction by the Esercizio Bacini Co.'s shipyard at Genoa, for the Royal Navy, three complete plants are being furnished by Tosi, and two by Fiat. This latter company, which formerly had built only large benzine motors for marine purposes has also been developing its own marine Diesel engines for submarines, an 850-hp. engine now being under construction for the German Imperial Navy.

The Italian Navy for years has been occupied with this question and has carried out a number of comparative tests, to determine a satisfactory type of engine for its submarines. Aside from submarines, the first experiment of the Navy with motor drive for war vessels was carried out this year upon two school ships, each equipped with a 1000-hp. Diesel engine, intended for the Naval Academy.

Nothing can yet be said as to the use of oil engines in the Italian merchant marine; aside from a few isolated experiments, attended with little success, the ship owners have not seriously taken up this matter. A few years ago, the Cantieri Riuniti built a motor freight vessel with Sulzer engines, and the Savoia Works an experimental vessel the "Savoia" with a 300-hp. oil engine, but the experience obtained has given little stimulus in the merchant marine.

The greatest opposing influence in the development of the oil-motor has been the high import duty on oil, which in spite of the economic superiority of internal-combustion engines, has not allowed manufacturers and ship owners to realize their economic advantage.

Primarily, the interested parties are endeavoring to reduce the limit of specific gravity by which certain motor-fuel oils, such as the so called Italian "naftetine," now enjoy special concessions. The density limit of naf-

*Translated and abstracted from an article in "Der Oelmotor," July, 1913.

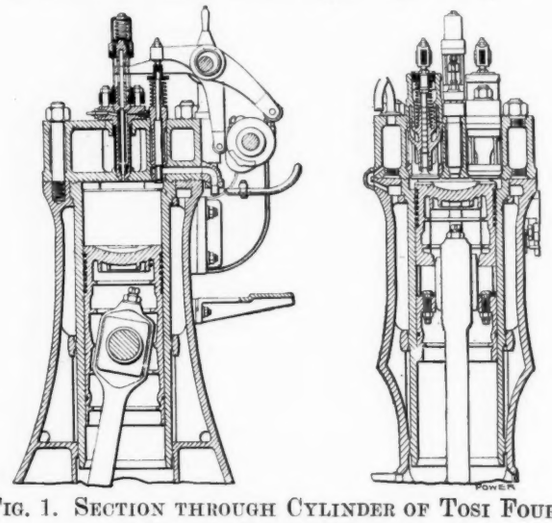


FIG. 1. SECTION THROUGH CYLINDER OF TOSI FOUR-STROKE-CYCLE ENGINE

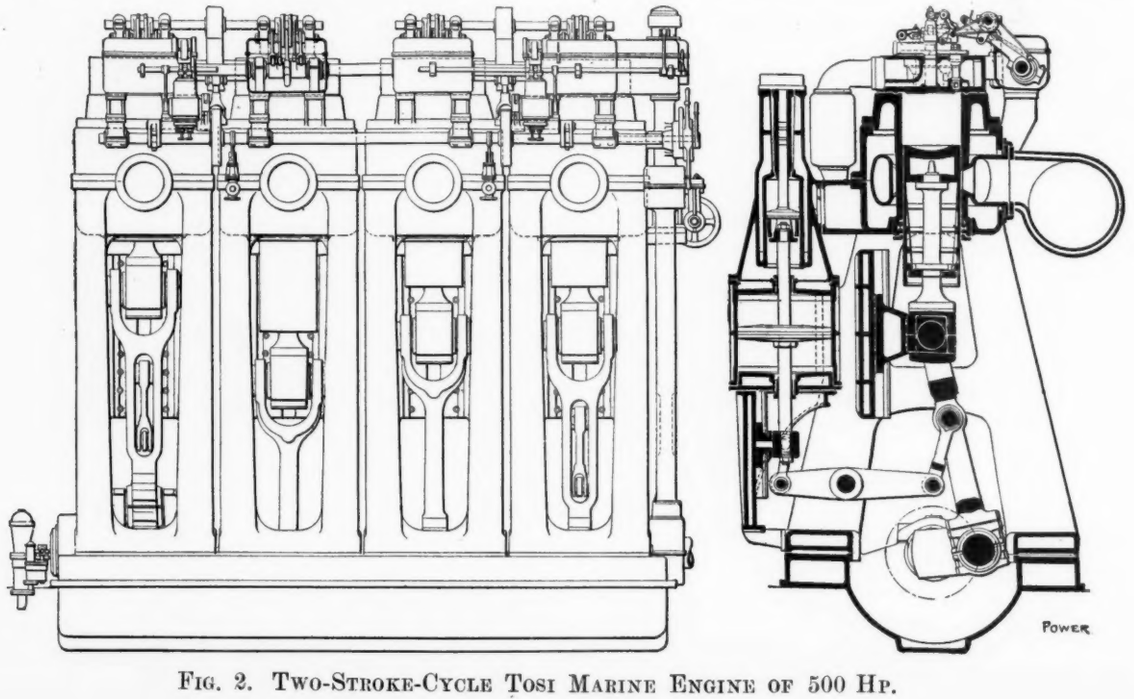


FIG. 2. TWO-STROKE-CYCLE TOSI MARINE ENGINE OF 500 HP.

tetine is, by the law of 1907, fixed at 0.925, and most of the motors built in Italy have proven unsuited for this.

Shops of Franco Tosi of Leghorn

The firm Franco Tosi, of Leghorn, is not only the largest, but the best organized machine-building works in Italy. It was founded in 1880 by Franco Tosi with 100 workmen, and today, under the leadership of his three sons, it employs some 2000 hands. The world-wide reputation which it has acquired in its comparatively short career is attributable primarily to the specialization of its manufacture, which comprises steam engines up to 5000 hp. (poppet-valve engines), steam turbines up to 20,000 hp., gas engines and oil engines of the Tosi-Diesel type. Following are the principal features of the Tosi oil motors:

Four-Stroke-Cycle Engines

The firm builds slow-speed and high-speed engines; the former range from 30 hp. per cylinder, and a speed of 210 r.p.m. up to 200 hp. per cylinder at 150 r.p.m. Units of this construction with four cylinders are made up to 800 hp. The high-speed engines are built from 15 hp. per cylinder and 350 r.p.m. up to 75 hp. and 300 r.p.m.

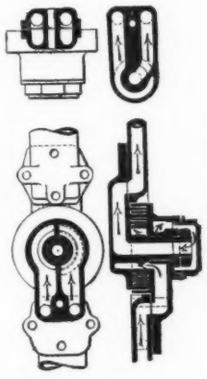


Fig. 3. Water Cooling of Tosi Engine

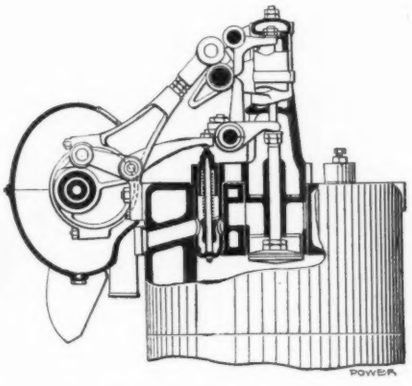


Fig. 4. Valve Details of Two-Stroke-Cycle Tosi Engine

The engines have very long plunger pistons, which for large cylinders are built in two parts. The piston rods and connecting-rods are of forged steel and have very broad bearings lined with white metal. The injection-valve rods are automatically lubricated, and large cylinders are provided, with water-cooled exhaust valves.

In the slow-speed type, the cylinders are cast separately from the box-pattern bed proper. The box bed of the high-speed engines consists of one casting on which the individual cylinders are built up. The compressor is of the multi-stage type and fills three receivers, one furnishing the air necessary for spraying the fuel, a second the starting air, and the third a reserve supply.

Two-Stroke-Cycle Engines

The two-stroke-cycle engines of the Tosi design are characterized by especially solid construction of the bed and base plate, by careful water cooling of all parts that come in contact with the hot gases and by the special design of the valve chamber with provision for expansion.

The upper connecting-rod journal is lubricated by a tube instead of through the connecting-rod itself, thus avoiding unnecessary throwing of the lubricating oil.

The commonest form of the Tosi two-stroke-cycle motors is the four- and six-cylinder crosshead type. Of these the firm has already built five of 1000 hp., running at 160 r.p.m., and three of 400 hp., the former for stationary plants, the latter for marine service.

By simply loosening the lower crosshead box and letting down the piston, the piston rings are very easily removed. A piston can also be taken out with facility without interfering with the lubricating system or removing the cylinder head.

Fig. 2 shows a 500-hp. two-stroke-cycle marine engine which runs at 170 r.p.m. As seen in the view at the right, the scavenging pumps are driven by links from two of the connecting-rods. The compressor is placed above these pumps.

By the separate arrangement of the scavenging pumps, these always handle clean and comparatively cool air, which contributes essentially to the useful power of the motor. Moreover, the independent position of these pumps permits driving them at a lower piston speed than that of the working pistons, thus lessening the air velocity in the passages and reducing harmful vibrations. This arrangement of the scavenging pumps distinguishes the Tosi engines from another Italian type, the Fiat. The latter has two-stage working pistons, the lower part of which serves as an air pump.

Fig. 4 shows a few details of the valves and Fig. 3 the water cooling of a Tosi two-stroke-cycle engine.

The Fiat Works, Turin

The first internal-combustion engines of the Diesel principle were finished by the Fiat firm in March, 1911. These were for driving the submarine "Medusa" and can be called the first Italian crude-oil engines. In a twelve-hour trial they developed at 452 r.p.m. 335 hp., with an oil consumption of 0.54 lb. per metric horsepower and fulfilled to the satisfaction of the Naval officials the conditions of burning the so called Italian "naftetine." This crude oil of Roumanian production has at 59 deg. F. a specific gravity of 0.940 and at 68 deg. a viscosity of 25.8 determined by the Engler method.

The Fiat concern is now building two-stroke-cycle engines of both low-speed and high-speed types. The low-speed engines weigh from 110 to 88 lb. per hp., and the high-speed type from 44 to 35 lb. per hp.

For the past two years the Fiat Co. has been working experimentally on large oil engines for driving warships, but no tangible results have yet been reached.

The Fiat motor is characterized by not having independent scavenging pumps. The pistons are stepped, and while the upper part, of smaller diameter, acts as a working piston, the lower part, of larger diameter, acts as an air pump. This arrangement has been chosen to reduce the length of the motor and to obtain a better balance.

The upper part of the bed serves as a scavenging-air reservoir and contains air at from 0.2 to 0.4 atmospheres, according to the speed. The scavenging air is led through passages cast integrally with the bed and cylinders to the air valves. In the top of each cylinder head are two air valves with an atomizer and with the admission valve to start the engine. The exhaust ports are uncovered by the piston just before the lower dead center. All exhaust passages are water cooled. The compressor which is of the two-stage type is placed at the front end of the motor and is driven by an extension of the crankshaft and produces the compressed air for spraying the fuel,

starting and controlling the engine. Besides the compressor there is a water pump for cooling the cylinder walls and exhaust passages and also the lubricating pump.

An eccentric on the camshaft drives the inlet valves for the scavenging air and the fuel ignition. To reverse, it suffices to turn the camshaft back through an angle twice that corresponding to the injection period. Fig. 5 shows the Fiat valve gear.

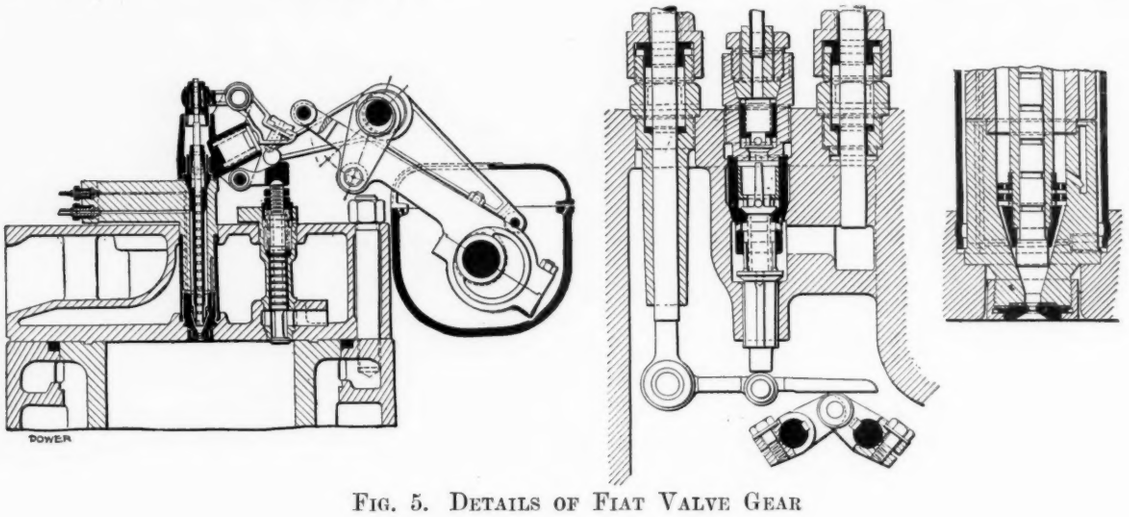


FIG. 5. DETAILS OF FIAT VALVE GEAR

SOCIETA ITALIANA LANGEN & WOLF, MILAN

The firm Langen & Wolf, of Milan, originally a branch establishment of the Deutz gas-engine factory, has lately developed, in addition to gas engines, one of the most important lines of Diesel engines for industrial purposes. Fig. 6 is a section through a four-cylinder, four-stroke-cycle engine of this make.

KÖRTING WORKS, SESTRIE PONENTE
(Societa Italiana Körting)

The German firm Körting's branch establishment in Sestrie Ponente has built a four-stroke-cycle constant-pressure internal-combustion motor which soon found a great demand in Italy. It is made exclusively as a horizontal stationary engine and works on the Diesel principle. The firm also builds gas, petroleum and benzine motors for agricultural purposes, motors for airships and for small boats.

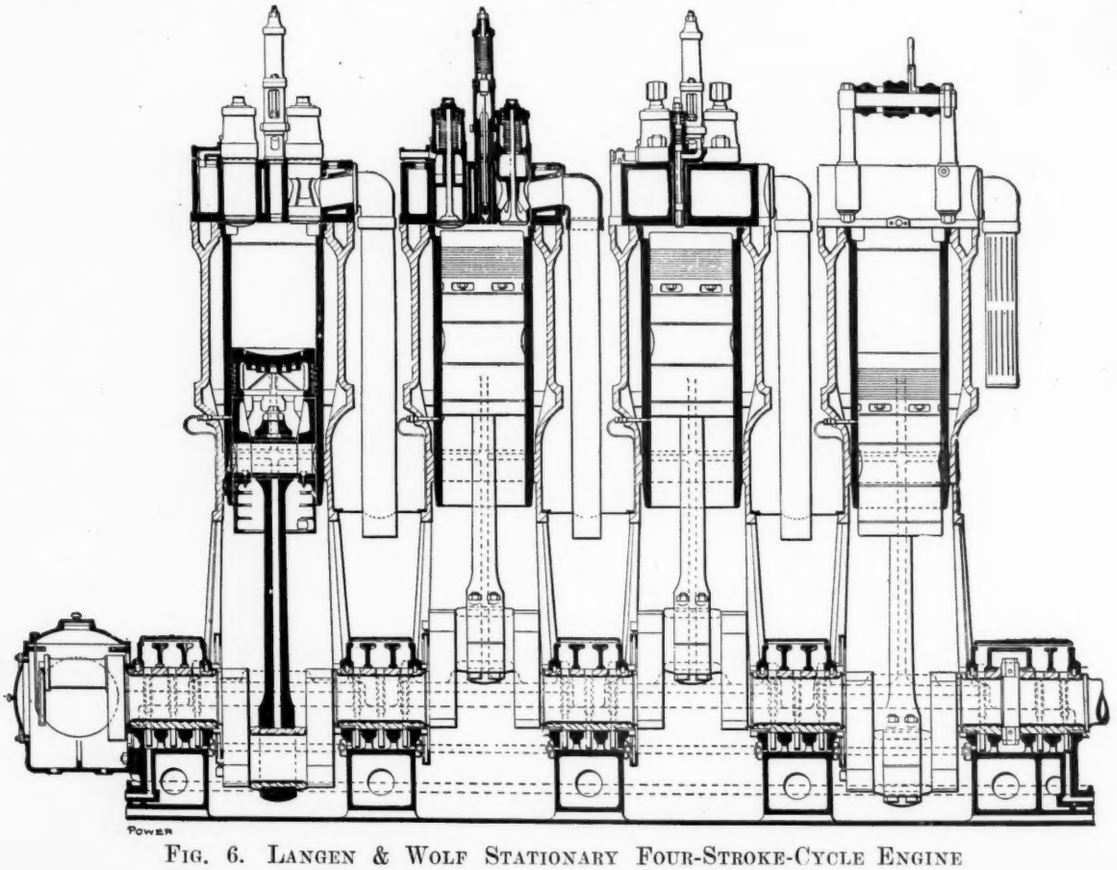


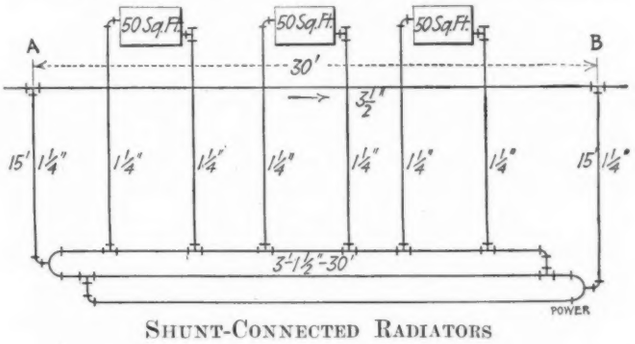
FIG. 6. LANGEN & WOLF STATIONARY FOUR-STROKE-CYCLE ENGINE

HEATING AND VENTILATION

Shunt System of Connecting Radiators

By Ira N. Evans

Several articles have appeared explaining the action of the shunt system of connecting radiation on hot-water heating apparatus. The articles referred to are by L. L. Brewster, Feb. 4, 1913; W. L. Durand, Apr. 1, 1913, and H. A. Kieselbach, Aug. 12, 1913. The first article is erroneous in many respects and the last is by far the best explanation, but none give any concrete figures as to exactly what occurs in any given case. This is an excellent method of connecting risers and radiators in gravity house-heating work, as it gives a single main pipe, and the possibility of bypassing is avoided. It is, however, impossible to connect radiators situated below the level of the main in this manner unless forced circulation is used. A proper relation of the expected velocities should be known even then if the apparatus is to circulate properly at all times. If the pumpage is varied to regulate the temperatures it is apt to interfere with the circulation on connections of this character.



Shunt-Connected Radiators

In gravity work as long as the main is hot, the radiators will take care of themselves, and if radiator connections are made 1¼ in. for the first floor and possibly 1 in. for upper floors, they will be large enough. All that is necessary, for a proper size main, is not to give too great a drop for the total radiation. Mr. Brewster's thermosiphon action is a new term for what happens on every hot-water job whether one or two risers are employed. As Mr. Durand states the action is caused in both cases by the difference in head between the two connections on the main. It is the purpose of this article to show how that difference in head may be calculated for any given case, as, for instance, the accompanying illustration, which shows radiator connections for an actual installation in a large institution in New York.

Mr. Brewster states, "It has been assumed and stated by some that the flow of water through the radiator is one of less resistance than that through the main but this is not the case." This statement is incorrect inasmuch as the resistance between A and B, Fig. 1, will be exactly the same for both main and shunt, the velocities changing to enforce the law, regardless of all other conditions.

Mr. Durand questions the practice of using 10 ft. per sec. in small mains. This may or may not be good practice as it is mainly a commercial question affecting the cost of installation. It is true that high velocities, where the head is great per unit of length, are not safe, due to possible inaccuracy of formulas at that point in the scale and that construction may not coincide with the plans.

Assuming a 4-in. main 1000 ft. long and a velocity of 8 ft. per sec., the head would be 69.1 ft. for the straight pipe. In another circuit on the same plant, 300 ft. long, the drop per 100 ft. would have to be 23 ft., and would mean a velocity of 10 ft. per sec. or over for all mains 2 in. and over with lengths 300 ft. or less.

If 4 ft. per sec. were the limit for small sizes, the long mains with large capacity would be unnecessarily expensive. This is almost wholly a matter of experience, judgment and initial cost. The drop in head should be known on all circuits and equal to the total head provided for circulation.

In the diagram, 6 ft. per sec. will be assumed for the 3½-in. pipe outside the shunt. Let

Q = Cubic feet of water flowing through 3½-in. pipe per sec.;
V' = Velocity in 3½-in. pipe within A and B;
V = Velocity in the shunt;
A' = Area of 3½-in. pipe;
A = Area of shunt.

Then

$$Q = A'V' + AV$$

The friction formula of Williams and Hazen developed in the July 9, 1912, issue of Power, reads as follows:

$$h = 0.00037 \times l \times \frac{V^{1.85}}{d^{1.166}}$$

The letters referring to the main will be designated by the prime mark and those referring to the shunt will be plain. Then

$$Head = l' \times \frac{V'^{1.85}}{d'^{1.166}} = l \times \frac{V^{1.85}}{d^{1.166}}$$

By solving the two expressions for the velocities it can be told whether the system will work or not. If the velocities are known and one diameter, the other diameter can be determined from the same equation.

The surface in the coil or radiator runouts, all of which are assumed to be 15 ft. long, will be for the 1¼-in. pipe

$$90 \times \frac{1}{2.3} = 39\ sq.ft.$$

and for the 1½-in. pipe

$$30 \times 3 \times \tfrac{1}{2} = 45\ sq.ft.$$

It requires 2.3 linear feet of 1¼-in. pipe and 2 ft. of 2-in. pipe to make 1 sq.ft. of surface. With radiators the total radiating surface will be 234 sq.ft. Assuming a maximum average water temperature of 200 deg., a room temperature of 65 deg., or 135 deg. difference, with 1.8 B.t.u. per hr. as the transmission factor, the total B.t.u. required per hour will be

$$234 \times 1.8 \times 135 = 56{,}862$$

The length of the three 1½-in. pipes in the coil in terms of 1¼-in. pipe is proportional to the areas, that is, the greater the area the shorter the length to be equivalent as far as friction is concerned.

Area 1¼-in. pipe = 1.5 sq.in. = 0.0104 sq.ft.; diameter = 0.115 ft.
Area 1½-in. pipe = 2.04 sq.in. = 0.0141 sq.ft.; diameter = 0.134 ft.
Area 3½-in. pipe = 9.9 sq.in. = 0.0687 sq.ft.; diameter = 0.297 ft.

The area of three 1½-in. pipes would then be

$$\frac{3 \times 2.04}{1.5} = 4.08$$

times the area of a 1¼-in. pipe. The equivalent length of coil in terms of 1¼-in. pipe, or the length of the shunt figured as 1¼-in. pipe will be

$$\left(\frac{1}{4.08} \times 30\right) + 30 = 37.353 \text{ ft.}$$

$$h = \frac{37.353}{30} \times \frac{V^{1.85}}{d^{1.166}} = \frac{V'^{1.85}}{d'^{1.166}}$$

Substituting the numerical values for the diameters and solving for V in terms of V' by logarithms, gives

$$\frac{V}{V'} = \sqrt[1.85]{\frac{\left(\frac{0.115}{0.297}\right)^{1.166}}{1.2451}}$$

$$\frac{V}{V'} = \frac{((\log 0.115 - \log 0.297) \times 1.166) - \log 1.2451}{1.85}$$

$$\frac{V}{V'} = \frac{(\bar{1}.0606978 - \bar{1}.4727564)\ 1.166 - 0.0952042}{1.85}$$

$$\frac{V}{V'} = \frac{-0.48091033 - 0.0952042}{1.85} = \bar{1}.688587 = \log 0.4882$$

$$\frac{V'}{V} = \frac{1}{0.4882} = 2.0483 \text{ or } V' = 2.0483 \times V$$

Whatever the velocities outside the shunt, the relation of the velocities of shunt and main between A and B will be as above. This is based entirely upon the fact that the drop between A and B is the same for the main and the shunt and directly contradicts Mr. Brewster's assertion.

The drop in head between the points A and B will be less per unit of length than outside, due to the greater area. As the 3½-in. pipe has an area of 9.9 in. and the 1¼-in. pipe 1.5 sq.in., the velocity through the combined pipes would be

$$9.9 \div 11.4 = 87 \text{ per cent.}$$

and the total friction between A and B would be $(0.87)^2$ or about 76 per cent. per unit of length of the friction outside the shunt. The total quantity of water flowing with a velocity of 6 ft. per sec. outside the shunt will be

$$6 \times 0.0687 = 0.4122 \text{ cu.ft. per sec.}$$

for the 3½-in. pipe. The velocity in the 3½-in. pipe will be 2.048 times that in the shunt and the velocity in the shunt will be 0.488 times the velocity in the 3½-in. pipe between A and B. The velocity in the 1¼-in. pipe will be

$$0.4122 = 0.0687 \times 2.0483\ V + 0.0104\ V$$
$$V = 2.7277 \text{ ft. per sec.}$$

Taking the weight of the water at the temperature as 60 lb. per cu.ft.

$$2.7277 \times 0.0104 \times 60 \text{ lb.} \times 60 \text{ min.} \times 60 \text{ sec.} = 6127.5 \text{ lb. per hr.}$$

If 56,862 B.t.u. per hr. are required, the maximum drop will be

$$\frac{56{,}862}{6127.5} = 9.28 \text{ deg.}$$

The friction heads due to these velocities will now be worked out to see if they are equal as they should be. For the 1¼-in. shunt the friction head will be

$$h = 0.00037 \times 37.353 \frac{(2.7277)^{1.85}}{(0.115)^{1.166}}$$

h = Log 0.00037 + log. 37.353 + (log 2.7277) 1.85 — (log 0.115) 1.166;

$h = \bar{4}.5682017 + 1.5723255 + (0.4357966)\ 1.85 - (\bar{1}.0606978 \times 1.166)$;

$h = \bar{4}.5682017 + 1.5723255 + 0.9062237 + 1.0952264$;

$h = 0.0419773 = 1.1005$ ft. head.

The friction head for the 3½-in. pipe will be

$$h = 0.00037 \times 30 \frac{(5.5872)^{1.85}}{(0.297)^{1.166}}$$

h = Log 0.0111 + (log 5.5872) 1.85 — (log 0.297) 1.166;

$h = \bar{2}.0453230 + 1.38230206 + 0.61476604$;

$h = 0.0423911 = 1.1025$ ft. head.

The two heads prove up to the third figure, which is as close as the data in the problem.

If the Fanning formula were used and the velocity squared the friction factor, which changes for each velocity and size, would have to be obtained by trial and error. Using the friction factor for the velocity as heretofore determined, it would be 0.03 for the 1¼-in. pipe and 0.025 for the 3½-in. pipe. Fanning's formula is

$$h = fl \frac{V^2}{d2g}$$

Substituting and placing the friction heads equal, with $l = 30$ ft. for 3½-in. pipe and 37.353 ft. for its equivalent in 1¼-in. pipe, gives

$$h = \frac{37.353 \times 0.03\ V^2}{0.115 \times 2g} = \frac{30 \times 0.025\ V'^2}{0.297 \times 2g}$$

Here $2g$ cancels and leaves

$$h = 9.7442V^2 = 2.52525\ V'^2$$

$$\frac{V}{V'} = 0.509; \quad \frac{V'}{V} = \frac{1}{0.509} = 1.964$$

Substituting as before to get the true velocity

$$0.4122 = 0.0687\ V' + 0.0104 \times 0.509V'$$
$$V' = 5.57 \text{ ft. per sec.}$$

for the 3½-in. pipe as compared to 5.587 from the Hazen and Williams' formula.

$$0.4122 = 0.0687 \times 1.964V + 0.0104\ V$$
$$V = 2.836 \text{ ft. per sec.}$$

for the 1¼-in. pipe as against 2.7277 ft. per sec. from the first formula.

In the one case logarithms have to be used and in the other trial and error to get the friction factor. It is seen that the friction formulas agree fairly close, but the Hazen and Williams' formula would be safer as it gives a lower value for the velocity in the shunt.

When the radiator is first started up, if below the main, the cold water has to be raised to the main and the pressure due to the difference in weight of the cold and hot columns deducted. Assume that the temperature of the main is 200 deg. and that of the radiator 50 deg., as this

condition might occur in cold weather with the radiator shut off and it was desirous of turning it on. The actual cooling of the radiator has little or nothing to do with the circulation or the stopping of it.

Water at 50 deg. weighs	62.41 lb. per cu.ft.
Water at 200 deg. weighs	60.14 lb. per cu.ft.
Difference	2.27 lb. per cu.ft.

Dividing the 2.27 by 144 gives 0.0158 lb. per sq.in. pressure for each foot in height, and as the height is 15 ft., the following head will be obtained, remembering that head equals 2.33 times the pressure.

$$0.0158 \times 2.33 \times 15 = 0.55 \textit{ ft. head}$$

As the friction head or power available is 1.10 ft. there will be sufficient head to produce circulation. As soon as the cold water is out of the radiator the velocity will be increased. The above assumptions presume a difference of 150 deg. If this were reduced to 10 deg. the normal drop in head due to gravity would be one-fifteenth, or

$$0.55 \div 15 = 0.036$$

It will be readily seen that in forced circulation with a drop of less than 10 deg. in the radiator gravity is practically eliminated.

❋

Elements of Heating

By E. N. Irwin

Heat may be defined as a form of energy caused by the molecular motion of the particles of any substance. Its manifestations are contraction and expansion with changes in temperature measured by a thermometer. Electricity and light are analogous forms of energy, but the theory is of slight importance to the student of heating as compared with the manifestations which affect the physical action of the media used in heating. All heating quantities are based on the British thermal unit, which is the quantity of heat absorbed by one-pound weight of water when raised in temperature 1 deg. F. The mechanical equivalent of heat is 778 ft.-lb., to the B.t.u., a foot-pound being the energy or work required to raise a weight of one pound through a distance of one foot against the force of gravity. These quantities give a basis of measuring work for both heating and refrigeration, as in either system there is a transfer of heat from one point to another.

Water has the maximum absorbing power for heat, and is taken as the standard for measuring the capacity of other substances. This is expressed as a ratio which is called the specific heat of the substance. Water is taken as unity, so that the specific heat of any other substance will be the number of British thermal units required to raise a unit weight of it 1 deg. Conductivity is the number of British thermal units that will pass through a substance per degree difference either side in a unit of time. It is of importance in determining loss of heat in buildings and the transmission of heat through surfaces from one medium to another. The thickness is important as a greater weight will increase the absorbing power and delay the heat transmission.

Heat is transmitted by convection, radiation and conduction. Convection is the absorption of heat by the passage of a fluid over a heated surface, and the heat absorbed is a direct function of the velocity of passage. The transfer by radiation is the passage of heat from one object to another when not in contact. The sun transfers heat to the earth entirely by radiation. A stove in a room acts both by convection and radiation. The passage of the air of the room over the heated surface effects a transfer by convection; the fire transfers the heat to the sides of the stove mainly by radiation and the passage through the sides of the stove would be by conduction. Objects raised in temperature near the stove and exposed to the rays of heat would absorb heat mainly by radiation.

The condition or state of matter whether gaseous, liquid or solid is merely one of temperature. Thus water is solid below 32 deg., liquid from 32 to 212 deg. under atmospheric pressure and gaseous at any temperature above 212 deg. Pressures above or below atmospheric will change the above temperatures.

The three mediums used in heating are air, water and steam. A heating apparatus may be defined as a system of conduits or pipes arranged to convey a fluid from the source of heat to the space to be heated. The apparatus would include the absorber (heater, boiler, etc.), and the radiator on either end of the system of conduits. The apparatus may form a closed circuit returning the fluid to be reheated or it may be an open circuit wasting the conveying fluid after extracting as much of the heat as possible in the space to be heated. The fluid may be circulated, first, by an expansion from a higher to a lower pressure and temperature; second, by a difference in weight of the fluid as it is cooled or heated; third, by mechanical means such as the application of a pump or blower. Air and water may be mechanically circulated by independent power and the temperature of the medium will be independent of the power of circulation, that is, the circulation can be maximum without any transfer of heat. Steam is always circulated by expansion from a higher to a lower pressure, the latter being obtained by extracting the heat of the fluid in the space to be heated. Air and water may be circulated by gravity, due to a difference in temperature, and, therefore, weight, in different parts of the system. In all cases where the fluid is not mechanically circulated, the circulation is dependent on a temperature difference and, therefore, affects the average temperature of the heating medium. With a given initial temperature the more rapid the circulation the lower will be the average temperature of the heating medium, and the larger the surfaces required.

In studying the flow of steam as applied to heating, a knowledge of its physical properties is necessary, and as will be seen a knowledge of these properties will show that the rules governing steam heating are the same whether high or low pressures are used. Every temperature of steam in contact with the liquid in a boiler has a corresponding pressure which is fixed in all cases. In this state the steam is said to be saturated. When the steam is not in contact with the liquid and is raised above the temperature corresponding to the pressure, it is superheated, and the number of degrees above the temperature corresponding to the pressure is the degree of superheat.

With saturated steam the percentage of entrained water determines its quality. For example, with 2 per cent. moisture the quality of the steam would be 98. A reduction in pressure will tend to vaporize this water if the heat is maintained constant or heat is added. This is what happens when steam traps discharge to atmosphere under pressure above atmospheric.

Latent heat is the amount necessary to vaporize a

pound of water from liquid to vapor at the same pressure and temperature. It decreases with an increase in pressure and sensible temperature. The same amount of heat is released when the vapor changes back to water, as when steam is condensed in a radiator.

Sensible heat is the temperature recorded on a thermometer when immersed in the vapor, and in the case of saturated steam determines the pressure corresponding. When superheated steam comes in contact with the liquid a transfer occurs. Water is evaporated until the temperature of the liquid and vapor become the same, and when this occurs the steam will be saturated. The pressure will change at the same time to correspond to the final temperature of both vapor and liquid.

Total heat is the sensible heat plus the latent heat at the corresponding pressure plus the superheat if any. In heating work, only saturated steam is considered, although sometimes conditions of slight superheat occur in high-pressure steam lines.

Specific volume is the number of cubic feet of steam to the pound for any pressure and temperature and is an important factor in the design of conduits or mains. The sensible heat determines the temperature at which a heating system is operated and affects the heating surface in boilers and radiators. Attention is called to the fact that the total heat of steam only varies about 53 B.t.u. between atmospheric and 300 lb. absolute, the sensible temperature varies between 212 and 417 deg., or 205 deg., while the latent heat per pound varies from 970 to 811 B.t.u. In most steam tables the heat is measured from 32 deg., and the absolute pressure instead of atmospheric is used, the former being 14.7 lb. more than the former.

A universal question asked when heating apparatus are under consideration, is: "What is the best system or medium to use, air, steam or water?" At present it is possible to design apparatus so as to satisfactorily heat any building by any one of the three mediums, and any of the methods may be unsatisfactory if the system is designed, installed or operated improperly.

If air is circulated as a medium by difference in temperature and compared with water circulated by gravity the effect of specific heat and volume is given in the following: Where the specific volume of a medium is low, much higher velocities may be maintained with the same given expenditure of power or a greater difference in weight produced due to a given difference in temperature. The amount of heat transmitted is proportional to the density per cubic foot or the reciprocal of the specific volume. Assume velocities of 300 ft. per min. for the air and 30 lb. per min. for the water. For a given heat supply the relative cubic feet and size of conduits will be given. The size of conduits will be proportional to the cubic feet of the fluid required and inversely as the velocities. The velocities will vary inversely as the densities and specific heats.

Let Ha equal the volume in cubic feet of the hot-air system and Hw the volume of the gravity hot-water system. Then

$$Ha : Hw :: sp.ht.\ water : sp.ht.\ of\ air :: 1 : 0.24$$

$$Density\ water : density\ of\ air :: 62.5 : 0.075$$

$$Velocity\ water : velocity\ of\ air :: 30 : 300$$

$$\frac{Ha}{Hw} = \frac{30 \times 62.5 \times 1}{0.24 \times 0.075 \times 300} = 347$$

The hot-air conduits will be 347 times the size of the hot-water pipes. As the velocities are 10 to 1, there will be required 3470 cu.ft. of air to transmit the same heat as a cubic foot of water. Due to the greater areas of main and corresponding outside surface the loss on the air system will be far greater for a given distance and the drop in temperature for the loss of 1 B.t.u. will be over four times that of the water. These are the real difficulties in handling air long distances as a medium for the transmission of heat. It is also true that the higher the temperature of the medium the greater the loss from radiation, and with air the greater the drop in temperature of the medium in transit.

Steam has low specific volume and high velocities, but the latent heat is an important factor which does not appear in a water system. The higher the average steam pressure the greater density and the smaller the pipe. The weight of steam at atmospheric pressure is 0.03732 lb. per cu.ft. and of water 62.5 lb. per cu.ft. The latent heat of the steam would be 970 B.t.u., while the drop on the water system would be only about 25 deg., or 25 B.t.u. per lb. The velocity of the steam would be about 3000 ft. per min. as against 30 ft. per min. for the water. The volume of steam over the water would be

$$\frac{62.5}{0.03732} = 1675\ times$$

Making a proportion in the same manner as before

$$Hs : Hw :: 62.5 : 0.03732$$
$$30 : 3000$$
$$25 : 970$$

$$\frac{Hs}{Hw} = \frac{62.5 \times 30 \times 25}{0.03732 \times 3000 \times 970} = 0.43$$

The water mains would thus be 2.3 times the size of the steam mains under the velocities and conditions named. Now, if the water was circulated 300 ft. per min., instead of 30, the water mains would be about one-fourth the size of the steam mains to do the same work. Of course, the water system requires the same size main for a return and the friction is greater than in the steam main. These figures are merely ratios giving an idea of how the physical properties of the different media affect the design of heating apparatus.

If the velocities are omitted, then the heat-carrying capacities per cubic foot will have the following relations:

$$\frac{Hw}{Hs} = \frac{62.5 \times 25}{0.03732 \times 970} = 43$$

or the water will have 43 times the capacity per cubic foot of the steam for delivering heat. The size of the mains reverses the ratio when the velocities are taken into account. The radiating surface is directly proportional to the difference in temperature and the coefficient of transmission, regardless of the medium. If the air, water and steam are at the same temperatures the same surface will be required, but a greater weight of air than of water will have to be passed over the surface, due to the low specific heat. In all cases this velocity is a function and from the above reasoning it will be seen that steam requires no more radiation than water if the temperatures of the steam and water are the same. The lower the temperature at which the heating system is operated, regardless of the medium, the greater the amount of surface and the higher the cost of installation.

EDITORIALS

Common-Sense Precautions

In a recent issue of POWER a contributor tells of an engineer who fell into a sump pit which was flooded with water. The place was inadequately lighted, and the pit was open and not even guarded by railing.

This accident is only one of a number of similar ones which occur altogether too frequently. There are innumerable plants where pit and pipe tunnels, shafts, raceways, etc., are in total darkness, and no attempt is made to prevent a person from falling into them. In some states it is made compulsory by law to safeguard employees in such places.

It reflects unfavorably upon the common sense of engineers not to take these precautions voluntarily. Much current is not required to properly light these places, and if they are not permanently lighted it should be insisted that the men use lanterns when going near or through them. Law suits for injuries received by employees and other disagreeable incidents can be thereby avoided.

⁂

The Third Congress of Refrigeration

The opportunity of a generation has just been afforded Americans interested in refrigeration, cold storage, ice making and the allied industries in having in this country the third international congress of refrigeration. The congress was a success, and the large attendance would indicate that it has been generally appreciated. Considerably over one hundred papers were delivered, and their publication in the proceedings which are to follow will make a valuable addition to the literature already in print.

The titles of the papers, which were almost equally divided between the sections, indicate in a general way the scope and character of the material presented. Quite a number of the papers were of foreign origin, and the exchange of ideas will, no doubt, be of equal advantage to all concerned, although a more extended discussion on the papers in the various sections would have greatly enhanced their value. Unfortunately, the contributed manuscripts arrived late, practically all of them at the last minute, and their publication was so delayed as to afford but little opportunity for a reading previous to their presentation. One man's ideas, particularly if he be an authority, are of value, but a discussion approaching any particular subject from many different angles adds to the general understanding and intrinsic value of a paper.

A number of resolutions were adopted by the various sections and referred to the general assembly of the congress or to the commission of the International Association of Refrigeration. The second section moved the general adoption of 143.5 B.t.u. as the latent heat of fusion of ice as explained in the report of the congress on other pages of this issue. The fifth section passed two resolutions referring to the transportation of refrigerated products by sea and rail, and the sixth section adopted resolutions referring to instruction and education in refrigeration, legislation and insurance against indirect damage. All of these resolutions were good and if followed out as intended should result in lasting benefit to the field as a whole.

Scientists and government officials of standing and some of the best engineers in this country attended the congress. According to the register there were thirty-five from France, twenty-five from Germany, eighteen from Russia, the same number from Austria, fifteen from Canada and lesser numbers from other countries in Europe, the British Empire, South America and even Asia. It is thus evident that the congress has a wide foothold in the various countries of the world and its influence will be felt in the 150 or more industries aided by artificial refrigeration.

A new era in refrigeration is just beginning and, as in the past few years, the development will be rapid. There will be plenty of work for the international association to do, and many questions for it to settle. Many of the best men in the field are included in its membership so that the ability is there to reflect credit on the organization. A continuation of the good work since its inception, five years ago, is to be looked for, and each succeeding congress should bear more fruit than the one preceding. So far this has been true and the gathering in Russia three years hence will, no doubt, live up to precedents.

⁂

Standardization of Boiler and Stoker Installations

The plea of Joseph Worker for real coöperation in standardizing boiler and stoker installations as told on page 500 of this issue, should be heeded.

While it is true that much has been done in this direction by the smoke-inspection departments of some cities, no movement of wide scope representing the concentrated efforts of boiler and stoker manufacturers and smoke inspectors has developed. It is hoped that the International Association for the Prevention of Smoke, before which Mr. Worker's paper was read, will be able to bring about such a movement. It is, perhaps, the organization best fitted for carrying on such work.

It is true that higher boiler settings, extended furnaces and stokers—in fact, all the requirements that make for commercially smokeless combustion of soft coal—cost more to install than equipments not specially designed for the fuel and load conditions, head room and floor space. The difference in price is the deterrent to their being more frequently adopted. Smoke-inspection departments might find it advantageous to circulate literature to the purchasers who are usually nontechnical men, showing that, although such installations are higher in first cost, they are far more economical than installations not so well adapted to the fuel and load conditions.

Previous to signing contracts, the purchaser should have his engineer call together the boiler and stoker manufacturers and smoke inspector for conference, so that such things as sizes of firebox, flues, chimneys, etc., may be agreed upon by each before the work commences. In this way, such unfortunate happenings as too little head room to allow of the proper distance between the grate and boiler, insufficient flue areas, due to structural features of the building, inadequate draft due to too small a stack; in fact, all these things which are discovered when it is too late to avoid great expense for remodeling, would then be avoided.

The Men You Keep

Occasionally men are found who have been employed by the same company fifteeen, twenty, twenty-five years or more. This long service indicates a relation existing between the men and the company officials that promotes good will and a feeling of interest on the part of the men in the affairs of the company.

In a certain company one workman has been employed about forty years, and, although his efficiency is waning, he still receives full time for what service he renders. This company sells ice and coal to its workmen at cost; buries a man if he is killed, and takes care of the dependent ones until they can take care of themselves.

This company has never had any labor troubles, and when necessary the men willingly work overtime and all night for regular pay. Most men who leave the employ of the company return at the first opportunity. This company is known by the men it keeps.

As a contrast, take any company whose officials are not in close relation with the men, and where the one idea is to get as many dollars out of their efforts as possible. There can be but one result, discontent. The men feel the absence of personal interest in them and take the position that so long as the company is looking solely after its interests, it is up to them to get as much out of the company as they can. Hence, work is slighted—no one does more than he is obliged to do to hold his job. Periodically the discontent reaches the stage where a strike results. Such a company is known by the men it keeps.

When a man habitually makes changes, the fault is generally with himself. When a large part of the men employed by a company keep changing it looks as if the company were at fault. It does not take long for a company to get a favorable or discredited reputation from the men it keeps.

Very many boiler rooms are known as hard propositions. The firemen employed today are all gone next month, none staying longer than to find another position. A look into such a boiler room usually shows it to be dark and dirty, undermanned and indiscriminately operated. A good fireman will not work in such a place or for a company maintaining such a boiler room. Therefore, second-rate men are employed, efficiency is lacking and the plant gets a bad name among the craft. Another instance of being known by the men employed.

There is one kind of a plant which engineers avoid, if they are acquainted with the situation; that is, where the president, superintendent or general manager assumes the office of chief engineer. No engine room is large enough for two individuals to assume charge without friction, and if the management of the steam plant is divided, no end of trouble will occur. Discipline is impossible; the men, not knowing from whom to take orders, naturally obey the man who is nearest the office. It is not uncommon where such conditions exist for the chief engineer to quit in a short time, unless he is content to "play second fiddle." The men in the boiler and engine rooms take matters into their own hands to a greater or less extent, and do pretty much as they please.

No real engineer, capable of running a good power plant, can accept such conditions and the plant soon becomes known by the men it keeps.

The *Bismarck* (N. D.) *Weekly Tribune* wonders thus: "Has North Dakota a man who has succeeded in doing the hitherto impossible? Has she a wizard who has been able to break the seal on the closed book of mystery, delve into the unfathomable depths of gravity, and reveal her secret which prohibits perpetual motion?"

No, our dear contemporary, she has not. You can bet your whole outfit on it, job press and all. And if the alleged inventor, whose portrait you publish, says that he has produced a machine which has run forty days without tapping some sort of energy, he is either a liar or has himself fooled to a frazzle.

And the next mail brings the *Los Angeles Times,* with a weird account of an engine which, its owners say, "generates its own power in violation of recognized rules of mechanics and accomplishes the alleged impossibility of producing more power than it generates (absorbs?). The noval feature is that the engine uses only air for fuel, the expansion of the air through heat producing a driving power, as well as power to produce more heat to expand more air."

The following lucid description of the invention is reminiscent of the ramblings of the lamented Keely: "Wires from the magneto keep the air at the proper temperature without loss of power or pressure. The vital principle which enables the engine to multiply its power sixteen times is explained as a piston device that turns a shaft which carries two heavy flywheels. On each end of the shaft is a toothed gear. A groove is formed in a mangled device in which the end of the shaft travels. The groove is elongated and so placed that as the gear turns the end of the shaft will hold the gear in contact with the toothed rack and this causes the connecting-rods to produce a reciprocative motion. The drive shaft makes two and a half revolutions during each compression stroke."

It will go into the long time of similar fizzles as the E. M. Barnes attempt.

The *Electrical Review* publishes the following frank avowal from the pen of Douglas S. Martin: "Where they have to fight the isolated plant, central-station men fight it not through personal animus toward the leaders of the movement, but because they are acting according to their convictions, and their convictions tell them that the isolated plant means waste. Therefore, they must set their rates to kill the isolated plant—not because they delight in killing, but because their line of business can only be run efficiently by raking in all loads and every kind of load."

READERS WITH SOMETHING TO SAY

Required Vacuum

Referring to the inquiry of F. E. K., in the Sept. 2 issue, I offer the following additions:

Because of the limited range of expansion in a reciprocating engine, the economy is limited. Owing to their great size and hence cost, cylinders could not be profitably built to allow for the tremendous increase in volume of steam when it is expanded to very low exhaust pressures. Consider the use of steam at an initial pressure of 165 lb. absolute; its specific volume in cubic feet per pound is 2.753, while at 1 lb. absolute it is 333. Imagine the size and cost of a cylinder necessary to utilize steam at the latter pressure. It would be simply prohibitive. Engines usually exhaust at about 6 lb. absolute and consequently all the available energy is not expended. Lower exhaust pressure would simply aid in decreasing the back pressure without any appreciable effect on the completeness of expansion. Even if it were possible to expand to 1 lb. absolute, any gain procured in expansion would be greatly offset because of the increased amount of condensation in the engine, unless highly superheated steam were used, and then the cost of the superheater would enter, for the fixed and operating costs of superheating must be taken into consideration in determining net gain, since the decrease in steam consumption would not be the actual saving.

H. W. Wetjen.

Newburgh, N. Y.

Home-Made Emery Wheel for Grinding Valve

I have heard and read of many ways of grinding valve seats, but never heard of a method like my own: Remove the disk holder from the valve stem and cut out the composition disk and fill up with emery with just enough thin glue to make the emery damp. Smooth off the top while damp and set away for a few hours; when the mixture hardens it makes a good emery wheel of the proper size. Place it in the valve and turn with a brace. If it is desired to use the disk holder in the valve, submerge it in warm water for a few minutes and scrape out the softened emery with a jack knife.

E. E. Thompson.

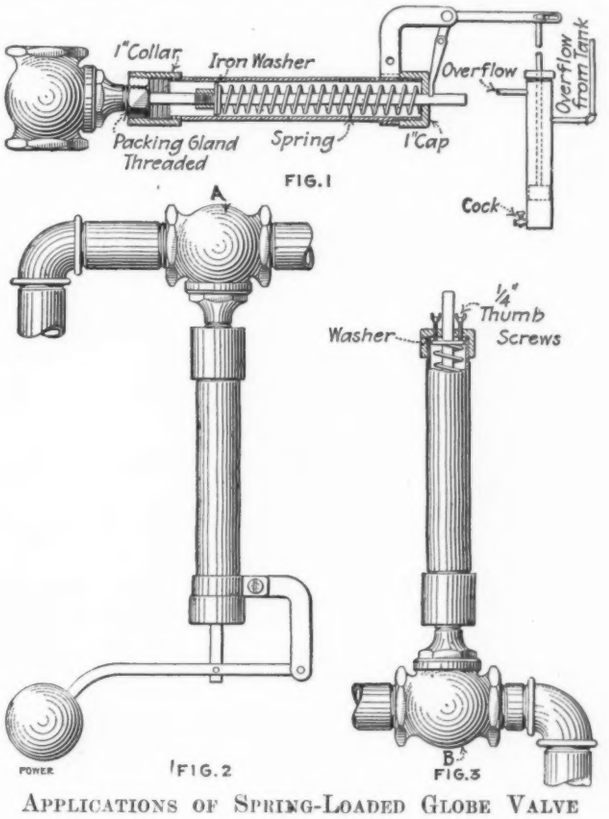
Thessalon, Ont., Canada.

Valve for Many Purposes

The illustrations show a valve that may be utilized for many purposes and made at little expense. Fig. 1 shows a valve I made several years ago to use as a safety stop on a pump used to fill a large tank with water.

This valve is made by threading the packing gland of a 1-in. globe valve after the threads have been filed off the stem and the stem extended as shown. A 1-in. collar and 1x8-in. nipple is screwed over the packing gland, first having placed a washer between the valve stem and the extension that will work free inside of the nipple. Over the stem place a spiral spring long enough so that when the cap is screwed on it will compress it slightly. Next pull out the stem as far as it will come, and cut a slot in it flush with the edge of the cap and arrange the trip as shown. The stop is then ready for service.

By removing the spring and attaching a float it makes a very good float valve, as shown in Fig. 2. By the addition of a washer as a compression plate and by tapping a ¼-in. hole on each side of the valve stem and inserting thumb screws (longer than illustrated), as shown in Fig. 3, a very good relief valve may be made, which may be regulated by compressing the spring. I have used this valve in many places and found it highly satisfactory.



Applications of Spring-Loaded Globe Valve

Claude R. Van Keuren.

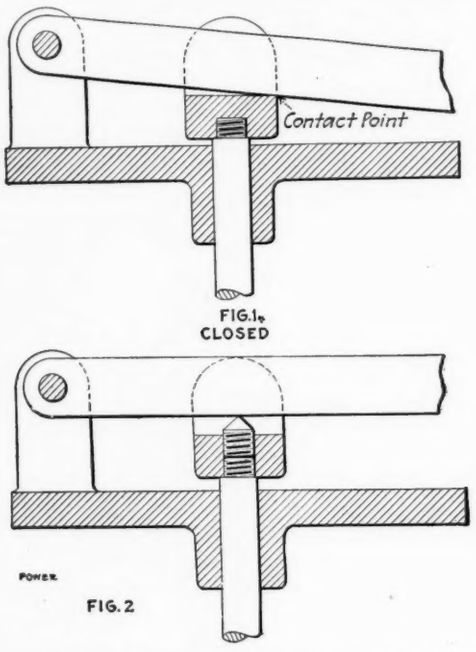
Famosa, Calif.

Leaky Safety Valve Repaired

I was called on to find what it was that caused a safety valve to operate in the following manner. The valve, when set to release at a certain pressure, would leak badly at a pressure far below the releasing pressure

and would not stop leaking until the pressure had fallen considerably.

On investigation I found that the trouble was due to the fact that the lever guide on the valve stem was flat. Fig. 1 shows the valve closed, the lever resting on the corner of the guide. The long fulcrum or guide



DEFECTIVE AND CORRECT CONSTRUCTION OF SAFETY VALVE LEVER

allowed the lever to lift at a low pressure until it rested flat on top of the guide.

When the pressure had risen high enough the lever would be lifted by the other corner of the guide, which was a shorter fulcrum. To remedy this I drilled and tapped the top of the stem and inserted a plug having a point, as shown in Fig. 2.

CHAS. G. BUDER.

St. Louis, Mo.

Crescent Cooling Pond Defended

The letter signed by Charles W. Wilson, New Castle, Penn., on page 163 of the Feb. 4, 1913, issue, contains statements concerning our lake at Wampump, which are absolutely unwarranted by the facts. We beg to state positively that we have no knowledge of a Charles W. Wilson or anyone representing him calling on us for facts or having visited our plant.

Now to take up his statements in order:

His statement that there is no movement of the water is incorrect. He seems not to realize that water may flow without making the movement apparent on the surface.

His statement that the entire volume of the lake warms up and remains hot until cold weather comes on again is also incorrect, unless he refers to water on the surface only. The lake varies from a depth of from 6 to 12 in. at the upper end to 16 ft. in depth at the lower end next to the dam, and one can readily see the impossibility of it becoming equally warm all over when one considers there is a constant taking of cold water from the lower end of the lake at the bottom, where it is 16 ft. deep, and the consequent continuous flow of water from the upper end, where it is from 6 to 12 in. deep. By actual record, carefully made hourly and noted on our log sheet, we find even in hot weather there is a temperature difference of about 30 deg. F. between the intake water and the tail water.

His suggestion, "But with the addition of a properly designed cooling system it would be very successful in keeping the water cool during the summer season when the mill is running continuously night and day," is simply a statement wholly incorrect, so far as our conditions exist, and goes to show that he does not know anything about the operation of our mill, which has been running almost constantly for four years and for the last 12 months has been operating continuously night and day, with the exception of a shutdown of about ten days. During the hot months of this summer we ran continuously at full capacity under most economical conditions. We consider that we have the best, practical and economical system to fit our conditions.

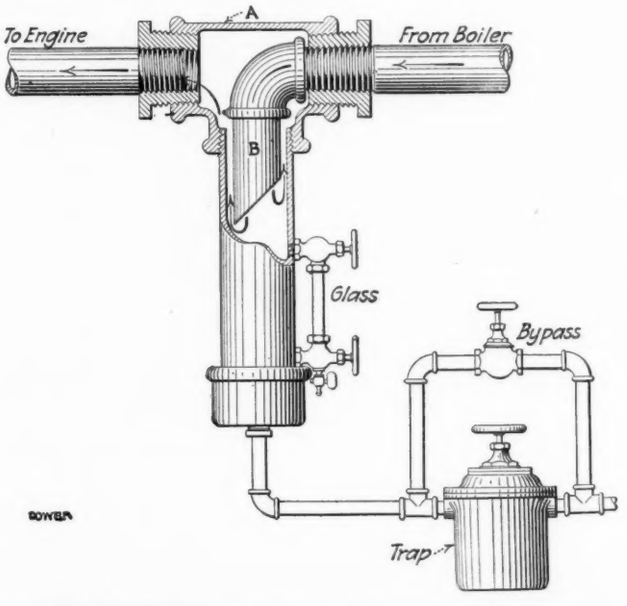
We do not have before us the article published in the Dec. 3, 1912, issue, but we have the original article from which it was abstracted. The original article appeared in the *Journal* of the American Society of Mechanical Engineers, being a paper read by our constructing engineer, W. B. Ruggles, of New York City, before the society. Mr. Ruggles is well known as an engineer of accuracy and truthfulness, and we write this letter principally to resent the careless, ignorant criticism of Charles W. Wilson. We invite any investigation that you or Mr. Wilson may see fit to make.

CRESCENT PORTLAND CEMENT CO.,
David M. Kirk, President.

Wampump, Penn.

Home-Made Steam Separator

The illustration clearly shows the construction of a steam separator made of pipe fittings. The size of the fittings used will, of course, vary with the size of line on which the separator is to be placed.



CONSTRUCTION OF SIMPLE STEAM SEPARATOR

The tee *A* should be much larger than the steam line to allow sufficient steam to get through the separator. By cutting the nipple or short length of pipe *B* on an angle, as shown, turning the long side toward the direction of flow, I believe more water can be taken from the steam than if the nipple is cut straight across.

A gage-glass is fitted to the drop leg and a steam trap is placed in the line draining this leg.

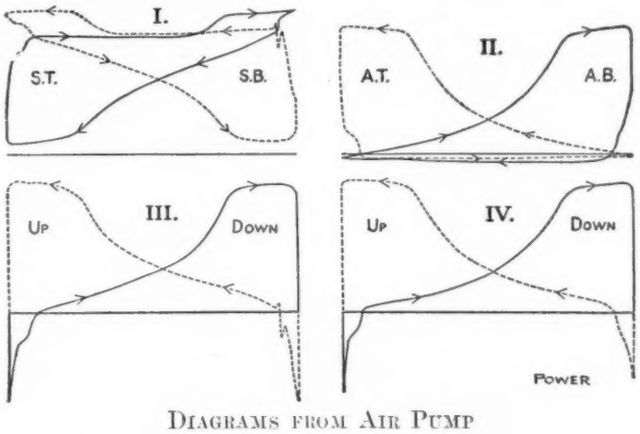
MARTIN MCGERRY.

Holley, N. Y.

Diagrams from Air Pump

In the issue of Aug. 15, Lester A. Fitts has given indicator diagrams from the steam end of a jet-condenser pump. The action of this type of machine is even more clearly shown by the diagrams herewith submitted, from both cylinders of an air-brake pump such as is found on every steam locomotive and is occasionally used as a small independent compressor.

The diagrams I and II are marked *S* and *A* for steam or air and *T* and *B* for top or bottom. Arrow-heads show



DIAGRAMS FROM AIR PUMP

the direction of tracing by the pencil, and two kinds of lines are used, to separate the two-cylinder ends distinctly and to show which diagrams go together: thus steam-top and air-bottom have their high-pressure stroke (steam admission and air compression) downward and their low-pressure stroke (exhaust and suction) upward.

The effect of and need for the peculiar form of the steam diagrams are made clear by the effective pressure curves at III and IV, from steam cylinder and air cylinder, respectively. These are derived by the usual method of combining pressures on the two sides of the piston. Effective steam pressure (III) is a driving force, in the direction of piston motion, when measured upward from the base line; effective air pressure, when similarly measured upward at IV, is a resisting force opposing the movement. The manner of variation of air pressure is, of course, the independent and determining action, to which the steam pressure must accommodate itself. A very close comparison of curves III and IV will bring out some discrepancies, apparently due to inaccuracies of indicator movement, but on the whole the agreement is very good, as it should be. The two pictures are of the same size, so that the steam and air curves are directly comparable.

A feature of construction which has a strong influence upon steam action, especially in causing throttling of exhaust and high-back pressure during the first, high-speed part of each stroke, is the use of very small steam ports. In this particular machine the port area is only about $\frac{1}{130}$ of the piston area, as against a ratio of about 1 to 10 in ordinary engines.

The machine is rigged for indicating by putting on a light extended piston rod, tapped into the lower end of the main rod. This passes through a special stuffing-box, which replaces the plug in the bottom cylinder head. The rod drives a suitable reducing motion, and the cylinders must be drilled and tapped for the indicators. This little compressor makes a very effective laboratory unit.

ROBERT C. H. HECK.

New Brunswick, N. J.

Jam Nuts

Your note at the foot of Charles Jablow's letter on "Jam Nuts" in issue of Sept. 9, will not hold water. You say, "it is both necessary to obtain the maximum draft before setting the jam nut and to obtain the position of the inside nut without backing it against the outside nut," etc.

With your method, when you set up the outside nut, you displace the inside nut by the amount of lost motion (and all nuts have some) and derange your bearing adjustment by just so much and take all the strain on the thin nut. I believe the cut is correct and the note is wrong.

C. H. MANNING.

Manchester, N. H.

Why Did Hot-Water Tank Fail?

The failure of a hot-water tank, described by Mr. Cederblom in the July 22 issue, was undoubtedly due to the breathing action of the tank ends. The breathing would be accentuated by the high pressure, the absence of air cushioning, and the neglect of the designer to adequately brace the ends with gusset plates or by other means. The pitting may have been assisted also by some deleterious ingredient in the water. Even with properly braced Lancashire and Cornish boilers the writer has frequently noticed a decided tendency to "groove" around the turned-over flange of the end plates (although such action does not usually become serious until the boiler has been in service for 10 to 20 years) and in practically every case the only reasonable cause to which the grooving could be assigned was the breathing action which undoubtedly takes place to some extent in all boilers, no matter how well they are stayed.

JOHN S. LEESE.

Manchester, Eng.

The greatest long-distance power transmission in southern Asia is in the native state of Mysore, power being transmitted from the Cauvery falls to the Kolar goldfields, 92 miles away, and to the cities of Mysore and Bangalore, about 40 and 86 miles away, respectively, for electric lighting and power purposes. Nearly all of the hydro-electric installation for this great enterprise was made in Schenectady, N. Y., and the only imports connected with this work not from the United States were waterwheels imported from Switzerland. An important extension for this great enterprise has recently been started, and the contract for all machinery except waterwheels has gone to the United States. Power is sold to the mining companies at $48 per horsepower-year.

ENGINEERS' STUDY COURSE

Boiler Efficiency—III

After a test has been conducted considerable work remains to be done in figuring out the results so as to make the report complete. Last week we gave an extensively used form of test report, partly filled in with the data of an imaginary test. While it should be possible for every reader who has followed this series with reasonable application, to fill in the balance of the report without further illustration, it seems desirable to present the calculations in full here to serve as a sort of review.

Fuel

The first item to be calculated is the total weight of dry coal supplied to the furnace, which is found by simply multiplying the total weight of coal as fired by 100 minus the percentage of moisture and dividing by 100 thus:

$$\frac{10{,}372 \times (100 - 7)}{100} = 9646 \text{ } lb.$$

The percentage of ash and refuse in the dry coal equals the total weight of ash and refuse taken out divided by the total weight of dry coal supplied and multiplied by 100, as follows:

$$\frac{1897}{9646} \times 100 = 19.67 \text{ } per\ cent.$$

To calculate the proximate analysis of the dry coal from the analysis of the coal as fired, add together the percentage of volatile matter, fixed carbon and ash, divide each in turn by their sum and multiply by 100, thus:

$$3.49 + 76.35 + 13.16 = 93$$

Then, the percentage of volatile matter in the dry coal is

$$\frac{3.49}{93} \times 100 = 3.75 \text{ } per\ cent.$$

the percentage of fixed carbon is

$$\frac{76.35}{93} \times 100 = 82.1 \text{ } per\ cent.$$

and the percentage of ash is

$$\frac{13.16}{93} \times 100 = 14.15 \text{ } per\ cent.$$

The same proceedure is employed in calculating the analysis of the combustible matter, except in this case the percentage of ash is also left out. This analysis is: Volatile, 4.37, and fixed carbon, 95.63 per cent.

Analysis of Ash and Refuse

An actual analysis of the ash and refuse may be made in the same way and with the same apparatus employed in making the proximate coal analysis or the analysis may be estimated. This is done by subtracting the estimated total weight of real ash from the actual total weight of ash and refuse, dividing the difference by the latter and multiplying by 100. This gives the percentage of combustible matter in the ash and refuse and the difference between this figure and 100 gives the percentage of incombustible matter. The figures in the present case are

$$\frac{10{,}372 \times 13.16}{100} = 1365 \text{ } lb.$$

estimated total ash and, hence,

$$1897 - 1365 = 532 \text{ } lb.$$

combustible matter in the ash and refuse, making,

$$\frac{532}{1897} \times 100 = 28 \text{ } per\ cent.$$

combustible matter in the ash and refuse and, hence,

$$100 - 28 = 72 \text{ } per\ cent.$$

incombustible matter.

The average weight of dry coal consumed per hour is the total weight consumed divided by the number of hours, or,

$$9646 \div 10 = 964.6 \text{ } lb.$$

and the pounds consumed per square foot of grate per hour is the total weight consumed per hour divided by the area of the grate in square feet, thus:

$$964.6 \div 62 = 15.55 \text{ } lb.$$

Heat Value of Coal

To estimate the heat value of the dry coal the chart given in the June 10 lesson will be required. The percentage of fixed carbon in the combustible matter has just been found to be 95.63. Locating this point on the bottom of the chart printed in the June 10 issue and tracing a vertical line up to the curve, then across to the left margin shows that the heat value of the combustible should be about 14,900 B.t.u. per lb. As the combustible matter composes but 85.85 per cent. of the dry coal, the heat value of 1 lb. of dry coal will be but 85.85 per cent. of that of 1 lb. of combustible, or,

$$\frac{14{,}900 \times 85.85}{100} = 12{,}792 \text{ } B.t.u.$$

and, as the combustible matter in 1 lb. of coal as fired equals only 79.84 per cent., the heat value of 1 lb. of coal as fired is only

$$\frac{14{,}900 \times 79.84}{100} = 11{,}896 \text{ } B.t.u.$$

To estimate the heat value of the combustible from the heat value of the dry coal as shown by the calorimeter test it is simply necessary to invert the latter part of the above process. The 12,600 B.t.u. shown by the calorimeter to be the heat value of 1 lb. of dry coal is really the heat value of the 0.8585 lb. of combustible contained in a pound of coal. Hence, the heat value of one whole pound of combustible must be

$$12{,}600 \div 0.8585 = 14{,}677 \text{ } B.t.u.$$

The heat value of the coal as fired is figured from the heat value of the dry coal, as shown by the calorimeter in exactly the same manner as in the case of the estimated values just illustrated. Thus, the heat value of the coal as fired is

$$\frac{12{,}600 \times 93}{100} = 11{,}718 \text{ } B.t.u. \text{ } per\ lb.$$

Moisture in Steam

The quality of the steam may be estimated by the formula given in the Sept. 16 issue as follows:

$$Q = \frac{(H - h) + 0.46\,(T - T_1)}{L}$$

For the conditions of the test H, the total heat of dry-saturated steam at atmospheric pressure, equals 1150.4 B.t.u. per lb.; h, the heat of the liquid corresponding with the pressure carried in the boiler, equals 300.6 B.t.u. per lb.; T, the temperature on the discharge side of the steam calorimeter, equals (see last week's lesson) 272 deg. F.; T_1, temperature of saturated steam at atmospheric pressure, equals 212 deg., and L, the latent heat of steam at the boiler pressure, equals 886.3 B.t.u. per lb. Substituting these values in the formula we have

$$Q = \frac{(1150.4 - 300.6) + 0.46\,(272 - 212)}{886.3}$$

$$= \frac{849.8 + 27.6}{886.3} = 0.99$$

or 99 per cent., which means that there was

$$100 - 99 = 1 \textit{ per cent.}$$

of moisture in the steam.

The water fed to the boiler per hour is the total water fed divided by the number of hours, thus:

$$83{,}125 \div 10 = 8312.5 \textit{ lb.}$$

The water actually evaporated per hour is the water fed per hour multiplied by the quality of the steam expressed as a decimal fraction, or,

$$8312.5 \times 0.99 = 8229.4 \textit{ lb.}$$

The formula of calculating the factor of evaporation, as given in the Sept. 9 issue, is

$$F = \frac{(H - t) + 32}{970.4}$$

For the conditions of the test H, the total heat above 32 deg. in the steam at boiler pressure, equals 1186.9 B.t.u. per lb., and t, the temperature of the feed water, is 199 deg. Substituting in the formula, we have

$$F = \frac{(1186.9 - 199) + 32}{970.4} = 1.051$$

The actual equivalent evaporation per hour is the actual evaporation per hour multiplied by the factor of evaporation, thus:

$$8229.4 \times 1.051 = 8649 \textit{ lb.}$$

The horsepower developed is the average actual equivalent evaporation per hour divided by 34.5; hence, the horsepower developed in the present test was

$$8649 \div 34.5 = 250.7$$

The percentage of builders' rating developed is found by dividing the horsepower actually developed by the builders' rating and multiplying by 100, thus:

$$\frac{250.7}{220} \times 100 = 114 \textit{ per cent.}$$

The water apparently evaporated per pound of coal as fired under actual conditions equals the water actually fed per hour divided by the weight of coal per hour as fired, or,

$$8312.5 \div 1037.2 = 8.01 \textit{ lb.}$$

The actual equivalent evaporation per pound of coal as fired equals the above figure multiplied by the quality of the steam (expressed as a fraction) and the factor of evaporation, thus:

$$8.01 \times 0.99 \times 1.051 = 8.33 \textit{ lb.}$$

The actual equivalent evaporation per pound of dry coal fired equals the actual equivalent evaporation per hour divided by the number of pounds of dry coal supplied per hour, or,

$$8649 \div 964.6 = 8.97 \textit{ lb.}$$

In estimating the analysis of the ash and refuse we found that a total of 532 lb. or 53.2 lb. of combustible matter fell through the grate to the ashpit.

The dry coal fired per hour weighed 964.6 lb. and of this 85.85 per cent., or 828.1 lb., was combustible matter. Hence, the percentage of combustible matter falling to the ashpit was

$$\frac{53.2}{828.1} \times 100 = 6.42 \textit{ per cent.}$$

As the combustible matter comprised 85.85 per cent. of the dry coal and as all the heat was furnished by the combustible matter, it is evident that the 8.97 lb. actual equivalent evaporation per pound of dry coal fired was really 8.97 lb. actual equivalent evaporation per 0.8585 lb. combustible matter fired. Hence, the actual equivalent evaporation per pound of combustible fired must be

$$\frac{8.97}{0.8585} = 10.45 \textit{ lb.}$$

But, 6.42 per cent. of the combustible fired fell into the ashpit, was unburned and, hence, supplied no heat. Therefore, the 10.45 lb. actual equivalent evaporation per pound of combustible fired is 10.45 lb. per

$$\frac{100 - 6.45}{100} = 0.9355 \textit{ lb.}$$

of combustible burned, or,

$$10.45 \div 0.9355 = 11.17 \textit{ lb.}$$

per pound of combustible burned.

The heat absorbed per pound of combustible burned equals the number of pounds of actual equivalent evaporation per pound of combustible burned multiplied by the latent heat of steam at atmospheric pressure, or 970.4. Then, in the present case the heat absorbed equals

$$11.17 \times 970.4 = 10{,}839 \textit{ B.t.u.}$$

and, as the heat value of a pound of combustible was found to be 14,677 B.t.u., the efficiency of the boiler is

$$\frac{10{,}839}{14{,}677} \times 100 = 73.58 \textit{ per cent.}$$

In a similar way the efficiency of the boiler and grate equals the actual equivalent evaporation per pound of coal fired, multiplied by 970.4 and divided by the heat value of 1 lb. of coal and all multiplied by 100, thus:

$$\frac{8.97 \times 970.4}{12{,}600} \times 100 = 69 \textit{ per cent.}$$

If the actual equivalent evaporation per pound of coal as fired was 8.33 lb., the number of pounds of coal as fired required to evaporate 1000 lb. of water from and at 212 deg. was

$$1000 \div 8.33 = 120$$

and as this quantity is

$$\frac{120}{2000} \times 100 = 6 \textit{ per cent.}$$

of one ton, the cost of evaporating 1000 lb. of water was

$$\frac{2.90 \times 6}{100} = \$0.174$$

OVER THE SPILLWAY

JUST JESTS, JABS, JOSHES AND JUMBLES

Several German students refused to toast their emperor in beer on his recent jubilee. One was expelled, one sentenced to confinement in the university dungeon. Rather than occupy a dungeon cell, we'd toast Anthony Comstock in hunyadi water.

⁂

Prof. Munier has forsaken his pedagogical career to go into business for himself. He's selling peanuts, popcorn, hot dogs and ice-cream cones. Here's a tip to our professorial friends now teaching the young idea how to shoot, and whose emoluments are too little. This is a business age, and we need the dough. Selling peanuts is the only shell game where you find the little pea under the shell you bet on.

⁂

Oil has seeped into the crematory business. One of its advantages is that complete incineration takes place in two hours—you're just ruined if they get you! While cremation may never become so popular as the seventy-two-dollar funeral, if you have a hunch that you'd like this type of ash-handling machine in yours, the oil-burner may appeal to you.

⁂

"The Boston Elevated does not pay its president $36,000 and other officials from $4000 to $15,000 a year because it wants to, but because it has to. Ability comes high!" Try this argument on the boss if you think you can get away with it.

⁂

It's marvelous, the growth of the refrigerating industry in these United States. Its machinery is capable of turning out nearly 20,000,000 tons of ice yearly and it has an invested capital of $150,000,000. What, no ice? Geddap!

⁂

Multimillionaires' incomes are largely imaginary and trifling, says a contemporary, when compared with the savings of us small fry. We don't speak to over a dozen of these "multi" chaps, but we're sympathetic, all right. Who's suffering now?

⁂

Prof. Wirth of Germany has invented a method of controlling fast-moving trains by electric waves. We have a new haven over here for a few bunches of any old kind of waves which will stop trains before they stop themselves by running into something.

⁂

Our human nature is sure funny. When Mayor Gaynor was alive the great majority of the press and the people seldom missed a chance to ridicule or sneer at him. The other day the editorial and news columns lauded him to the skies and hundreds of thousands of that dear public lined the sidewalks as the funeral procession passed, baring their heads to do him reverence. Say, we are funny!

⁂

There's more than seven hundred billion tons of coal in the world's reserves. Coal is about the only thing that isn't almost ruined by the early frost every spring, thereby sending the price up into the heavens. Let's be thankful for that.

⁂

Nobody knows! After forty years' service as an engineer, unmarred by a single accident, Irwin De Raney was killed in the yard five minutes after affectionately patting his old locomotive and bidding his friends goodby. De Raney had just retired and the next day was to be put on the pension list.

⁂

There's a movement on foot to have an electrical-resuscitation hero medal for men who save the lives of victims of electric shock. It's a good stunt if for no other reason than the examination before the award compels the hero to give some valuable information as to how he did it.

⁂

Electricity has taken to the woods and has driven the picturesque lumber-jack, some of him at least, from his old-time trade. A motor-driven timber-hauling and loading apparatus now clears a radius of 4000 ft. without having to move the outfit. Next they will be cutting and driving by electricity—perhaps.

Getting to Work under the New Indiana Inspection Law

Thirty boiler insurance company officials, attaches of the state boiler-inspection department, and John Gallavin, boiler inspector, under the state bureau of inspection, held a meeting in the house of representatives at the state house recently, to discuss the Indiana boiler inspection law, passed by the 1913 legislature. The meeting was called by Mr. Gallavin to study the question of the application of the new law throughout the state. A desire to avoid confusion in the interpretation of the statute was responsible for the meeting, Mr. Gallavin said. Supervisors of boiler insurance companies from several states appeared at the meeting.—"Indianapolis News."

⁂

National Tube Co. Awards Prize

At the Springfield Convention of the N. A. S. E. the National Tube Co. exhibited an N. T. C. regrinding valve which had been used for several years on a machine testing Kewanee unions. Engineers were given an opportunity to guess how many times it had been opened and closed, the number of times corresponding, under the conditions of its use, to the number of unions tested.

An affidavit was on file signed by Mr. Marshall, of the National Tube Co., Kewanee Works, to the effect that it had been opened 2,650,000 times, and the nearest estimate was that submitted by William H. White, 61 Fulton Ave., Rochester, N. Y., superintendent of the Rochester Railway & Light Co., his estimate being 2,648,500 times. Mr. White received the walrus-skin bag which was offered to the person making the nearest estimate.

⁂

W. A. Blonck Lectures on Boiler Practice

On Monday evening, Sept. 29, W. A. Blonck, of Chicago, inventor of the Blonck boiler efficiency meter, gave a very interesting talk before Newark, N. J., No. 3 Association of the N. A. S. E. About 120 engineers heard Mr. Blonck. The lecture was by direction of the State Educational Committee.

Mr. Blonck deplored the lack of thorough standardization in boiler furnace, stoker and chimney construction and design, stating that he did not expect one standard to answer for the East and West, with their varying fuel conditions, but there was no reason why these things should be installed on the hit-or-miss plan now so common. The speaker claimed that investigations in numerous plants led him to believe that where stokers were installed, the engineers did not give the stokers the attention required for best results, and hence these boiler plants were not operating as efficiently as ordinary hand-fired plants.

Charts showing curves of CO_2 percentages and steam in pounds as shown by steam flow meters in the Fisk St. station of the Chicago Commonwealth Edison Co., where 120 boilers are installed and where 4000 tons of coal is burned per day, were shown. The steam quantity line as plotted from records made by a steam-flow meter showed very great fluctuations which did not check with the lines plotted to show the indications of the Blonck boiler efficiency meter attached to the boiler being tested. Investigation showed that these fluctuations were not due to any changes in the furnace or in the intensity of the fire, but to the water tender opening the feed valve admitting much feed water (at 212 deg. F.), thus momentarily reducing the steam production. The increase lines of the peaks, indicating a sudden increase in production, were caused by sudden demands for steam which reduced the pressure enough to cause much water to flash into steam.

The speaker stated that investigations by himself revealed that drops as great as from 140 to 60 per cent. boiler rating occurs, due to the causes mentioned above and not to any changes in furnace temperature or volume of gases passed. For this reason one should be careful not to blame furnace conditions for all steam quantity fluctuations indicated by a steam flow meter.

A practice condemned by the speaker and one which he said was unbelievably common was that of running boilers underloaded. Mr. Blonck mentioned numerous plants recently visited by him, where there were three or more boilers to a plant and each boiler was operating at half load and sometimes less. When a boiler cannot be run steadily at about 125 per cent. rating without burning the arches and setting, the speaker said, there was something wrong with the settings, yet this condition is by no means uncommon. He pointed out that there was a too credulous acceptance of the apparent fact that maximum draft meant maximum steam production.

Third International Congress of Refrigeration

The Third International Congress of Refrigeration is now a matter of history. Delegates to the number of 147 from 20 foreign countries were present and 600 from our own country were registered. A large number of papers were presented, some of exceptional interest, and an excellent exposition of refrigerating machines, materials and processes added greatly to the interest of the meeting, as America's latest and best achievements in the refrigerating line were there and thus showed in the best possible way the present state of the art. Other associations and societies related to the refrigerating field held their conventions at Chicago during the Congress, so that upward of 2500 men interested in refrigeration or cold storage were present to take some part in America's first Congress.

During the week of Sept. 7 to 13, many of the foreign delegation arrived in New York and spent the time sight seeing in and about the city until Sunday, Sept. 14, when the entire party left for Washington. On Monday, Sept. 15, the formal organization of the Third International Congress of Refrigeration was effected at the auditorium of the National Museum in Washington. Dr. F. W. Gunsaulus, of Chicago, president of the Congress, presided. In the absence of the President of the United States, William Jennings Bryan extended a semi-official welcome. Doctor Gunsaulus in the opening address pointed out that "waste of food is a crime against civilization," and that the remedy was to be found in refrigeration. A few remarks on the organization of the Congress were made by W. J. Rushton, of Birmingham, Ala., president of the American Association of Refrigeration. Andre Lebon, president of the International Association of Refrigeration, ex-Minister of the Colonies and ex-Minister of Commerce, Paris, France, was then presented and thanked the American Government for the hearty welcome extended. Short addresses by representatives of various countries followed and the rest of the day was spent in seeing some of the attractions of Washington. In the evening an official reception was given at the Pan-American Union Building. On Tuesday morning, President Wilson returned in time to greet the delegates, who immediately left for Chicago, the center of the cold-storage industry in this country.

Hotel La Salle was headquarters for the Congress. Wednesday morning, Sept. 17, was given over to registration and an official welcome to Chicago by Corporation Counsel Sexton, acting in behalf of Mayor Harrison who was absent from the city. In the afternoon the six sections of the Congress held their opening organization sessions, which were short and consisted of presidential addresses, announcement of honorary presidents, reading of rules and regulations and the reports of commissions. Thereafter with the exception of Friday, when everybody went to Milwaukee, one session was held daily, the balance of the time being devoted to entertainment, sight-seeing and social functions.

Many of the papers presented before the six sections are not of special interest to "Power" readers, but the following complete program of the papers will give some idea of the scope and nature of the subjects treated.

SECTION I. LIQUIFIED GASES AND UNITS

President, William Kent; vice-president, D. S. Jacobus; secretary, Calvin W. Rice.

Papers: "Lecture on Liquid Air and Its Uses," by Georges Claude; "Notes on the Work of the Section for Physics, Chemistry and Thermometry of the First International Commission of the International Association of Refrigeration," by Prof. H. Kamerlingh Onnes; "Critical Point of CO_2—a Possible New State of Matter," by Gardner T. Voorhees; "Report on the Unification of the Values, Units, Terms and Symbols Used in the Refrigerating Industry," by P. Juppont; "Essay on the Equations of Dimensions," by P. Juppont; "Observations and Propositions Relative to the Nomenclature and the Formation of Symbols for Refrigeration Values," by P. Juppont; "The Latent Heat of Fusion of Ice," by H. C. Dickinson, D. R. Harper and N. S. Osborne; "Heat from the Fusion of Ice," by A. Leduc; "Discussion of Earlier Measurements of the Thermodynamical Properties of Ammonia and Methylchloride," by G. Holst; "Some Physical Properties of the Liquid and Gaseous Phases of Ammonia," by Robert B. Brownlee, Henry A. Babcock and Frederic C. Keyes; "Optical Magnetic Phenomena at Very Low Temperatures, Divers Phenomena of Phosphorescence at Very Low Temperatures, Hall's Phenomena at Low Temperatures," by Jean Becquerel; "Production of Hydrogen," by Dr. F. Linde.

SECTION II. REFRIGERATING MACHINERY AND INSULATING MATERIALS

President, Dr. Alexander C. Humphreys; vice-president, N. H. Hiller; secretary, Van Renselaer H. Green.

Papers: "What Thickness of Insulation Should Be Used in Refrigerating Plants," by Ernst Rossner; "Insulation," by R. L. Shipman; "Compressed Exhaust Steam for Ice Making and Refrigeration—New Method and Apparatus," by Gardner T. Voorhees; "Some Suggestions as to Speed Rating for Ammonia Compressors," by Horace C. Gardner; "Multiple Effect Absorption Machines and Their Employment for Heating," by Edmund Altenkirch; "The Refrigerating Machine as a Heating Means—Reversible Heating," by Bernard Tenchkof; "Preliminary Report from the Thermal Testing Plant of the Pennsylvania State College," by J. A. Moyer; "Comparative Installation and Operating Cost of a Combined Ice Manufacturing and Cold Storage Plant," by R. H. Tait and L. C. Nordmeyer; "On a Method of Calculating the Thickness of the Insulating Walls of Cold Storage Rooms," by M. L. Marchis; "Concrete in Cold-Storage Warehouse Construction," by J. H. Libberton; "Telethermometers and Telehygrometers for Cold Stores," by F. W. Robinson; "Multiple Effect Compressors and Multiple Effect Receivers," by Gardner T. Voorhees; "A New Air Refrigerating Machine Eliminating the Use of Water," by C. Monteil.

SECTION III. APPLICATION OF REFRIGERATION TO FOOD

President, Dr. Harvey W. Wiley; vice-president, C. H. Parsons; secretary, Dr. M. E. Pennington.

Papers: "Australia and New Zealand as Sources of Meat Supply," by A. W. Pearse; "Factors Influencing Changes in Storage Butter," by L. A. Rogers; "The Different Methods of Refrigeration Compared from the Standpoint of the Hygrometric Conditions of the Air in the Cold Rooms," by A. Blanchet; "Source and Distribution of Fruits and Vegetables Handled in the Minnesota Primary Markets," by C. W. Thompson; "Local Cold Storage in Canada," by J. A. Ruddick; "Wisconsin as a Factor in the Nation's Supply of Butter," by Prof. C. E. Lee; "Bacterial and Enzymic Changes in Milk and Cream Kept at 0 deg. C.," by Pennington, Hepburn and St. John; "Preservation of Eggs by Refrigeration in Sterile Air," by M. F. Lescarde; "Application of Refrigeration to Fruit Juices," by H. C. Gore; "Notes on Investigation of Better Methods for Preserving Fish by Artificial Cold," by S. M. Bottemanne; "The Use of Refrigeration in the Preparation of Dried Cultures of Bacteria," by L. A. Rogers; "Rural Cold-Storage Plants—A Scientific and Economic Necessity," by P. H. Bryce; "Vital Statistics of Refrigeration—Its Present Status in Different Countries of the World," by A. W. Pearse; "Speculation as an Element in the Cold Storage of Food," by Herbert H. Pease; "The Effect of Prolonged Cold Storage on the Chemical Composition of Fish," by W. G. Gies; "Report of Work Done by Scientific Members of the Commission for the Investigation of Better Methods of Preserving Fish by Artificial Cold," by A. B. Droogleever-Fortuyn; "The Fish Production of the Great Lakes of the United States and Canada and the Practical Application of Refrigeration on Freezer Storage," by C. C. Robbins; "The Fish Production of the Pacific Coast of the United States and Alaska and the Practical Application of Refrigeration on Freezer Storage," by J. J. Maddock; "Freezer Storage as Applied to the Fish Production of the New England Section and the Atlantic Coast of the United States," by M. J. Talson; "Observation on the Use of Refrigeration and Freezer Storage in the Fish Industry of the United States," by Kenneth Fowler.

SECTION IV. INDUSTRIAL REFRIGERATION

President, M. L. Holman; vice-president, R. H. Tait; secretary, Prof. E. H. Ohle.

Papers: "The Relation of Refrigeration to Biological Materia Medica," by A. W. Parker Hitchens, M. D.; "The Condensation and Conservation of Wine and New Wine by Means of Cold," by Dr. Johannes Caspar; "Progress Made in the Use of Low Temperatures in the Textile Industry," by Dr. F. Erban; "Pipeline Refrigeration," by G. F. Bein; "A New Method of Ventilation for Dry Air Cold Storage Plants Using Natural Ice," by Anton Genert; "Air Cooling and Dehumidifying," by J. I. Lyle; "Artificial Ice Making and Refrigeration from the Standpoint of the Central Station," by C. H. Stevens; "Refrigerating Process for Purifying Hydrochloric Acid," by A. Le Roy; "Application of Refrigeration in the Chocolate Industry," by L. Bordenave; "The Employment of Refrigerating Machines in the Austrian Paraffin Industry," by Phillip Porges; "Cryotheraphy," by Prof. Bordas; "Outdoor Artificial Ice Rinks, Their Management and Hygienic Importance," by Edward Engelman; "Refrigeration in the Perfumery Industry," by C. de Chessin Cherchevsky; "Ice Formation," by R. A. Barnes; "Cost of Manufacture in Distilled Water Ice Plants," by Peter Neff; "Application of Refrigeration in the

Brewery," by A. Blanchet; "Proper Temperatures to Carry Furs and Fabrics," by Albert M. Read; "A Study of Refrigeration in the Home and the Efficiency of Household Refrigeration," by John R. Williams; "Refrigeration and Central Station Service," by Charles J. Carlsen.

SECTION V. RAILWAY AND STEAMSHIP REFRIGERATION

President, W. C. Brown; vice-president, C. M. Secrist; secretary, E. F. McPike.

Papers: "Dimensions, Proportions, Capacity and Insulation of Refrigerator Cars," by R. H. Parks; "Organization for Transportation of Perishable Products under Refrigeration," by J. S. Leeds; "Theory and Practice of Using Ice in Transit to Prevent Freezing of Perishable Goods," by Peter Neff; "Practical Means of Shifting Refrigerating Cars on Tracks of Different Gages," by A. Charron; "Transportation of Perishable Freight on the Russian Railways," by Prof. D. N. Colovine; "The Need of Uniform Regulations and Supervision of Refrigerated Transportation by Rail," by Richard Bloch; "Coördination of the Efforts of the Great Steamship Companies and the Railroad Companies in Behalf of Refrigerated Transportation," by Richard Bloch; "Laws and Regulations Relative to the Transportation of Perishable Commodities," by Richard Bloch; "Progress in France in Refrigerated Transportation by Sea," by Maurice Roux; "Transportation of Perishable Goods by Barges," by Walter B. Pollock; "Relative Consideration of the Need of a Comprehensive Organization by Transportation Companies," by A. M. Mortensen; "Methods of Precooling Perishable Goods," by B. W. Redfern; "Handling Manufactured Ice at Icing Stations," by H. B. Wood; "Method of Protecting Perishable Freight from Loss and Damage in Freezing Weather and the Use of the Recording Thermometer," by William Maclaier; "Methods of Precooling Perishable Goods at Loading Points," by C. M. Secrist; "Facilities Maintained by Railroads for Replenishing Ice for Refrigeration in Transit," by C. M. Secrist; "Refrigeration on Ocean Steamships," by C. J. Beck; "Mechanical Traction of Merchandise and the Use of Trucks on Tramway Tracks for Running Refrigerator Cars over Tracks of Different Gage," by Emile Druart; "The Refrigeration of Dressed Poultry in Transit," by M. E. Pennington and A. D. Greenlee; "The Advantages of a Combination Heater and Refrigerator Car," by W. E. Sharp; "Consideration of the Necessity of Uniform Regulations to Facilitate and Control the Circulation of Refrigerator Cars in Interstate Commerce, Including Their Possible Transfer in the Loaded State to Boats Over Rivers and Other Bodies of Water," by H. M. Wigney; "Consideration of the Means at Present Employed in Railway Cars for Effecting Refrigerated Transportation of Perishable Goods Therein," by G. C. Bohn; "Frigorific Transportation by Land in the Argentine Republic; Its Evolution Since 1910," by Dr. Jose Tomas Soho; "Frigorific Transportation by Water: Its History and Development from 1867 to 1913, Especially from the Point of View of the Transportation of Frozen and Refrigerated Meats from the Argentine Republic," by Pedro Borges.

SECTION VI. LEGISLATION AND ADMINISTRATION

President, Hon. James R. Mann; vice-president, Frank A. Horne; secretary, Barry Mohun.

Papers: "Insurance Against Indirect Damage," by Albert Krueger; "The Legal Status of Cold-Storage Warehouse Receipts in the United States of America," by Albert M. Read; "Laws and Regulations Affecting the Storage of Perishable Food Products Under Refrigeration in Public and Private Warehouses," by Dr. H. E. Barnard; "Liability of Warehousemen for Loss or Damage Where Goods are Stored in Rooms to Which the Customer Alone Has Access," by Walter C. Reid; "Insurance Against Indirect Damage," by Joseph G. Hubbell; "Sprinkler Leakage as Affecting Warehousemen and Their Customers," by Joseph G. Hubbell; "Instruction in the Science and Application of Refrigeration in the United States," by S. S. Van Der Vaart; "Present Status of the Refrigerating Industries in America," by S. S. Van Der Vaart; "The Status of the Refrigeration Industry in Austria," by Prof. Alois Schwarz; "Collective Report on the Status of Instruction on Refrigeration," by Prof. Alois Schwarz; "Regulating of Cold Storage as a Means of Reconciling the Interests of Both Public Hygiene and Commerce," by M. H. Hartel; "Laws and Regulations Affecting the Transportation of Perishable Goods as to Shippers' Duty and Carriers' Liability," by Charles Conradis; "Instruction in Refrigeration in France," by Prof. L. Marchis; "Effectiveness of Existing Laws Regulating Cold Storage Warehouses and Products," by Frank A. Horne; "Instruction in Refrigerating Industries in Russia," by N. Borodin; "The Duty of the Warehouseman in View of the Requirements of the Uniform Warehouse Receipts Act in Regard to Negotiable Warehouse Receipts and of Cold-Storage Laws Prohibiting the Retention of Goods in Cold Storage for Longer Than Prescribed Periods," by Barry Mohun; "Laws and Regulations Affecting the Transportation of Perishable Goods, as to Shippers' Duties and Carriers' Liability," by Henry C. Nicholson; "The Refrigerated Meat Industry in the Argentine Republic: Its Evolution Since 1908," by Pedro Borges.

PAPERS OF GENERAL INTEREST

For the latent heat of ice, values of 141 to 144 B.t.u. per lb. have been used. A correct and uniform value the world over is of the greatest importance, as on this unit all refrigerating capacities are based. As may have been noticed two papers on this subject were presented before the first section. Values of 79.63 and 79.6 calories per gram at 59 deg. F., or approximately 143.5 B.t.u. per lb., were given respectively in each paper. The value first given was determined at the Bureau of Standards, Washington, D. C., and the latter value by A. Leduc, professor at the Faculty of Sciences, Paris. Such close agreement between the two figures would indicate accuracy, so that for all practical purposes the above value might well be taken. It was left to the second section, however, to recommend to the commission of the International Association of Refrigeration the general adoption of the value 143.5 B.t.u. as the true latent heat of fusion of ice.

Of the other divisions sections II and IV were most productive of papers interesting to the power field. In the second section there were three papers on insulation, giving methods of computing the thickness required. The one by R. L. Shipman was the most complete of the three and discussed particularly the temperature line method of testing and rating insulations, which seems to give fair promise of simplicity and accuracy.

In one of his papers for this section, Gardner T. Voorhees proposed a method of compressing the exhaust steam from an engine for use in an absorption system. According to the author the generator usually requires too high a pressure to be economical in the exhaust of a steam engine. To obtain the pressure required for the most efficient operation an independent compressor is installed and by the use of 1 lb. of live steam from the boiler, 3 to 4 lb. of exhaust steam is compressed to the proper pressure and delivered to the absorber. A large increase in economy is claimed for the system. In the discussion it was brought out that practically the same method was in use in France and Switzerland over 25 years ago, and it was feared that the difficulties which the proposed arrangement would meet in actual practice might overbalance the increase in economy. In his second paper Mr. Voorhees considered the construction and economy of his multiple effect compressors and receivers.

An interesting paper on multiple effect absorption machines was presented by Edmund Altenkirch, of Berlin, and in another paper Bernard Tenchkof proposed to use the waste heat from the condenser and the engine of a compression system for hot-water heating. The heat generated in the condenser and absorber of an absorption system may also be used in the same way. Claims of a possible saving of 80 per cent, in the cost of heating were made.

A paper of exceptional interest to the practical man was that by R. H. Tait and L. C. Nordmeyer on "Comparative Installation and Operating Costs of a Combined Ice Manufacturing and Cold-Storage Plant." The base of comparison was a plant having a capacity of 60 tons of ice per day of 24 hr. and a cold-storage capacity of 100,000 cu.ft. requiring 20 tons of refrigeration or 12 tons ice-making capacity. The cost was figured first with a simple steam plant, second with a compound condensing plant and third with the Diesel engine. In the same order the comparative costs per ton of ice were $2.10, $1.97 and $1.65, giving a considerable margin in favor of the Diesel engine.

In the fourth section most of the papers naturally dealt with the application of refrigeration to the industries. There were a few, however, more closely related to the power plant. In his paper G. F. Bein discussed the possibilities and described a central plant distributing ammonia through a system of underground mains to its customers, with expansion valves at each service. Peter Neff gave some excellent data on the cost of manufacture of distilled water ice in plants of 10 to 100 tons capacity in 24 hr. The cost per ton varied from $1.42 to $2.60 depending on the size of the plant.

Service from the central station for refrigerating plants was discussed in papers by C. H. Stevens, of the Edison Electric Illuminating Co., of Brooklyn, and Charles Carlsen, of the Commonwealth Edison Co., of Chicago. In each paper an interesting collection of data was presented on plants requiring as much as 500 hp., although in most cases the connected horsepower was less than 30. The development of the raw-water plant, in which very little if any distilled water is required, has opened up opportunities for the central station which did not exist with the distilled-water plant. Some

of these papers will be abstracted at greater length in succeeding issues.

On Tuesday the sections held their last sessions, and on Wednesday morning, Sept. 24, the International Association met as a body, deciding to hold the Fourth Congress of Refrigeration in Russia. The afternoon saw the formal closing ceremonies of the Congress.

THE BANQUET

Of the varied entertainment during the Congress the banquet on Tuesday evening, Sept. 23, in the Hotel Sherman Casino, at White City, was easily the feature. It was a brilliant affair dedicated to cold storage, the articles on the menu dating back from two weeks to sixteen months. Fully 1000 sat at table and listened with interest to the speakers of the evening: Hon. William E. Mason, Senator Lawrence Y. Sherman and Hon. Andre Lebon, of Paris.

EXPOSITION

From Sept. 17 to Oct. 1 the International Exposition of Refrigeration was open to the public. It was held in the Dexter Pavilion at the stock yards and was a remarkably good exhibit. Its primary object was to create public confidence in cold storage and show that such foods are as healthful as those not subjected to refrigeration. Secondly, opportunity was given the foreign delegation to see the best in ice making and refrigerating machinery and its application as practiced in this country. There were operating and still exhibits of refrigerating machinery, engine-room equipment, appliances and specialties; exhibits of supplies and materials, exhibits by commercial interests, exhibits of refrigerator cars and precooling systems and displays of food stuffs held under refrigeration.

All the large manufacturers of compression and absorption systems had exhibits and there was a fair representation of raw-water ice-making systems. The Arctic Ice Machine Co. showed its compressors, brine cooler and condenser and a block of raw-water ice made by the Arctic-Pownall system. A small raw-water ice-making plant complete was exhibited by the Baker Ice Machine Co. The Carbondale Machine Co. had a small demonstration absorption system in actual operation taking exhaust steam at 2-lb pressure from a small generating set. A Corliss engine-driven compressor, counter-current condensers and a 20-hp. crude-oil engine formed the exhibit of the De La Vergne Machine Co. The Frick Co. had a large exhibit of horizontal and vertical compressors and its condenser, and similar exhibits of their products were displayed by the Triumph Ice Machine Co., and the York Manufacturing Co. The Vilter exhibit consisted of a 125-ton compressor direct connected to a tandem Corliss engine kept in motion by a motor belted to the flywheel. The Huetteman & Cramer Co. had a complete raw-water plant in operation. Kroeschell Bros. Ice Machine Co. displayed a 50-ton horizontal carbonic anhydride compressor and other equipment belonging to the compression system, and the Henry Vogt Machine Co. showed a 20-ton exhaust-steam absorption system. The United Ice Improvement Co. demonstrated the Parsons "Quick Freeze" system, with a tank holding eight 300-lb. ice cans.

There were numerous exhibits of packing, insulation, ammonia drums, cooling towers, piping and fittings, pumps, power-plant specialties, ice-handling machinery, evaporators, instruments, reboilers and water purifiers, ice cans, etc., besides a number of commercial displays of refrigerated products. The above, however, were too numerous to permit of individual mention.

Some of the features which attracted popular attention were liquid air demonstrations by Georges Claude, of Paris, a sculpture of a polar bear and Eskimo in refrigerated butter by the Beatrice Creamery Co., of Chicago, a mechanical oil farm showing derricks, tanks, etc., by the Standard Oil Co., the ice fountain near the entrance to the pavilion, and the Government's huge refrigerator containing displays of fruit, vegetables, meat, poultry, fish, eggs, cheese and other products.

The ice fountain was designed by Eugene T. Skinkle, of Chicago, and was made up in the form of a circular tower with pipe coils furnished by the Rempe Co., of Chicago. There were four terraces, the lowest one being 8 ft. in diameter and the others 6, 4 and 2 ft., respectively, with a ball on top 1 ft. in diameter. Brine was circulated in the coils and a coating of ice formed over the exterior. Within the fountain were located a number of colored lights of different tints, which as they were switched on produced color effects that were most pleasing and attractive.

Immediately behind the fountain was the Government's magnificient exhibit of food products. The huge refrigerator was 150 ft. long, 20 ft. wide and 18 ft. high, with display windows all the way around, so that the interior containing the various products previously mentioned was exposed to view. Pipe lofts extended above the rooms, the amount of piping being proportioned to the temperatures to be maintained in each compartment. Brine was circulated in the coils and was under full control so that the temperatures might be varied at will.

It may be of interest to state that the exposition was conceived by the industry itself. No private capital had any connection with it and the profits from the sale of space and the gate receipts reverted back to the exhibitors. There was a large attendance not only of refrigerating men, but also of home people who were interested only in the consumption of refrigerated products, so it is fair to assume that the exhibition was a success and accomplished the ends sought by the industry.

Welcome to N. A. S. E. Officers

A well attended and very enjoyable welcome was tendered to the national officers of the National Association of Stationary Engineers, by the Modern Science Club, 125 South Elliott Place, Brooklyn, Tuesday evening, Sept. 29. Of the national officers of the N. A. S. E., James R. Coe, president, John J. Reddy, conductor, past national presidents, William Reynolds and Joseph Carney and J. D. Taylor, secretary of the Life and Accident Insurance Department were present. The speeches of President Coe and Conductor Reddy were well received.

Entertainment and refreshments added to the pleasure of the occasion. Those who took part in the entertainment were Herbert Self, Peerless Rubber Co., the New York Quartette, consisting of John Lloyd Wilson, of Swan & Finch Co., Frank J. Corbett, now in business for himself; M. J. O'Connell, N. J. Mechanical Rubber Co. and Bob Jones, Jack Armour, of "Power," Billy Murray, Mabel Burke, Joe McKenna and Monroe Silver, all of Jenkins Bros.

Dr. Diesel Disappears

On Sept. 30, special cable dispatches to the daily press announced the disappearance of Dr. Rudolph Diesel, the inventor of the Diesel oil engine, under most mysterious circumstances. The New York "Times" says that Dr. Diesel left Antwerp on Sept. 29 to attend in London the annual meeting of the Consolidated Diesel Engine Manufacturers. He embarked on the steamer "Dresden," accompanied by a fellow-director, George Carels, and Herr Luckmann, chief engineer of the company.

Dr. Diesel had a cabin to himself. On the arrival of the vessel at Harwich at 6 o'clock a.m., he was missing. His bed had not been slept in, though his night attire was laid out on it.

It is conjectured by his friends that Dr. Diesel fell overboard. He complained to a friend some time ago that he was occasionally troubled with insomnia, and it is possible that when his friends retired to their cabins he decided to continue to stroll on deck. He was in the best of health, in very cheerful spirits, and had expressed most sanguine expectations as to the future of his engine and the development of the company.

Manning, Maxwell & Moore Purchases Putnam Machine Co.

The entire stock of the Putnam Machine Co., Fitchburg, Mass., has just been purchased by Manning, Maxwell & Moore, Inc., of New York.

The Putnam Machine Co. is the pioneer tool manufacturer of the country and was the originator and builder of the Putnam engine. S. W. Putnam, son of the founder and himself a designer of wide reputation, and his son, S. W. Putnam, will retain their connection with the company, which will keep the name of the Putnam Machine Co., and be operated on its own identity.

About the first of October, the stock of the Manning, Maxwell & Moore Co., which has heretofore been carried at 85 Liberty St., will be carried at the Jersey City distributing station, 446 Communipaw Ave., Jersey City, N. J., from which point shipments will be made. The concern has recently taken new offices of about 24,000 sq.ft. (double their present office quarters) on the twentieth and twenty-first floors of 119 West Fortieth St., New York, which will be occupied shortly after Oct. 1.

Receiver Explosion Fatal to Two

Twenty minutes after starting the 525-kw. Greene-Wheelock, cross-compound condensing engine in the plant of the Waclark Wire Co., Bay Way, N. J., Monday morning, Sept. 15, the receiver head blew out, killing two oilers and badly burning Frank B. Smith, the chief engineer.

The receiver is located below the floor, and between the high- and low-pressure cylinders. It is provided with two safety valves, 3 and 2 in. respectively, on the exhaust line

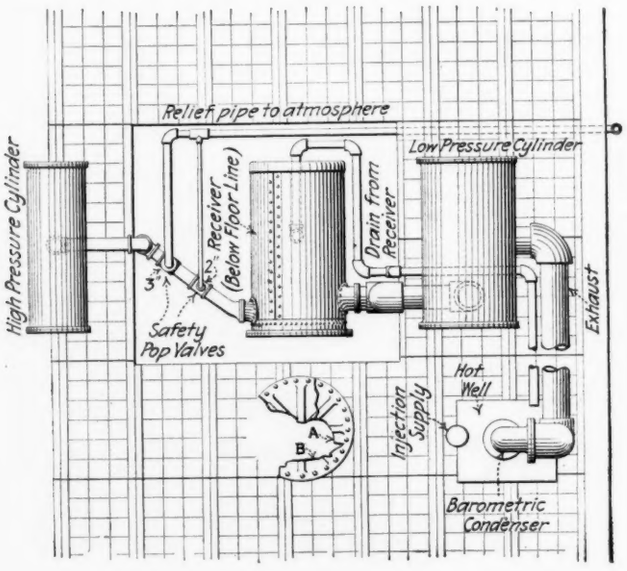


FIG. 1. PLAN OF RECEIVER PIPING

from the high-pressure cylinder. These valves are connected to a relief line leading outside the engine room to the atmosphere as shown in Fig. 1. The engine had been started at 7 a.m. and the two oilers and the watch engineer were standing between the two cylinders observing the engine until the vacuum was built up and everything running well. Satisfied that all was well, the assistant so informed the oilers and started away. When just beyond the high-pressure cylinder the explosion occurred, lifting the floor as shown,

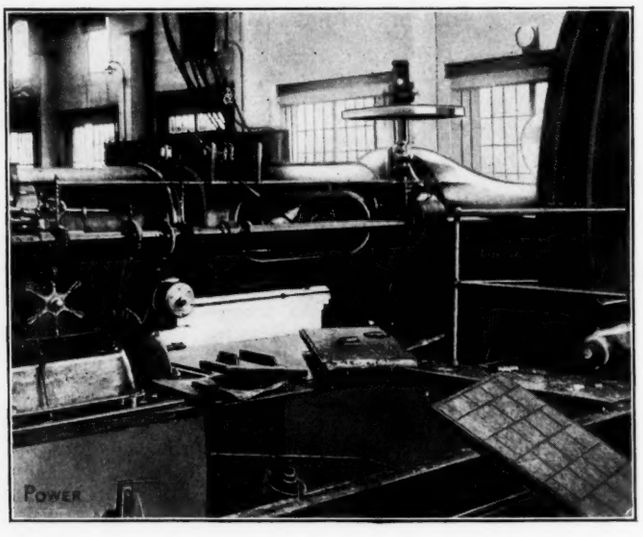


FIG. 2. FLOOR OF RECEIVER PIT BLOWN AWAY

Fig. 2, and almost instantly scalding the oilers to death. The chief engineer by this time had reached the throttle, but as he started to close it, he saw through the dense steam, the form of one of the oilers whom he then tried to rescue. It was this act of heroism that caused steam to scald the chief, as the oiler lay on the pieces of flooring directly over the broken receiver head from which steam, at boiler pressure (145 lb.) was issuing.

The engine was carrying 2200 amp., which is about one-half rated load, at the time; the vacuum gage registered 25 in. The receiver drain pipe shown leads to the hotwell, there being no trap in the line.

There is no evidence of water having been sucked into the receiver from the hotwell through this drain pipe because of a vacuum in the receiver due to an extremely early cutoff in the high-pressure cylinder. There was no water in the receiver pit except the little from the condensed steam.

Although the wreckage could not be disturbed for examination, because prohibited by the coroner, the visible edges of the broken receiver head shows signs of having had an incipient crack between the points A and B, Fig. 1. The metal here exhibits deep red rust in places and is of a different color from the other parts of the break which appear dark gray and fresh. As there was no undue amount of water present, and conditions show that the low-pressure admission valve operated, and as the cast-iron head of the receiver indicates weakness, one reaches the conclusion that one of the admission valves was held open, admitting steam at initial pressure to the receiver, and that the safety valves failed to operate until simultaneously or nearly so with the explosion of the receiver That they operated is evidenced by the presence of fine rust on the ground at the mouth of the relief pipe. These valves were set to blow at 30 lb. pressure.

PERSONALS

E. A. Stierly has been appointed chief engineer of power station of the Newport News & Old Point Comfort Ry. & Electric Co., at Hampton, Va., succeeding H. I. Holleman.

William J. Neville has been appointed manager of the Southern territory of the Chapman Valve Manufacturing Co. with offices in the Candler Building, Atlanta, Ga. For the past two years the company had its offices in Birmingham, Ala.

SOCIETY NOTES

At the last annual convention of the Practical Refrigerating Engineers Association, at Atlanta, Ga., in December, 1912, Hot Springs, Ark., was named as the place for the 1913 convention. Since that time, circumstances have arisen which caused the board of directors and officials to consider some other place for the convention. It was finally decided that Dallas, Texas, would best serve the interests of the association under the circumstances. Preparations are being made to make this convention interesting and successful.

OBITUARY

SETH C. ADAMS

Seth Collins Adams, an electrical engineer, connected with the Westinghouse Electric & Manufacturing Co., at New York City, died at his home in Rochelle Park, New Rochelle, N. Y. Mr. Adams was born in 1866 and was a graduate of Hamilton College.

WILLIAM C. SELDEN

William Cary Selden, a consulting mechanical engineer, who had much to do with the early development of steam navigation in the United States Navy, died at his home, 313 Washington Ave., Brooklyn. He was eighty-one years old, but had been active in his profession until last summer, when his health began to fail.

GEORGE C. KARME

George C. Karme, secretary of the Hills-McCanna Co., manufacturers of steam specialties, 153 West Kinzie St., died suddenly on Sept. 21, in his office, supposedly of heart disease. Mr. Karme appeared at 9 o'clock in the morning and announced that he had planned a hard day's work and did not wish to be disturbed. A half hour later a clerk said he saw Mr. Karme at the office door beckoning to him. He was gasping for breath. The clerk obtained brandy at a drug store and called a physician, but Mr. Karme died within fifteen minutes, before medical aid could reach him.